THE EFFECTS OF CHANGES IN CONSTRAINTS ON ACCESS TO VIDEO GAME PLAYING ON ALCOHOL CONSUMPTION

BY

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A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1986

ACKNOWLEDGEMENTS

I would like to thank Rudy Vuchinich, Ph.D., for his guidance and assistance in this project. Without his support and enthusiastic participation it would not have been possible. I would also like to thank Jalie Tucker, Ph.D., whose interest and consultation in this endeavor were always welcome, James Johnson, Ph.D., and Anthony La Greca, Ph.D., who offered their critical, scientific acumen, and Hugh Davis, Ph.D., whose humor, sensitivity, insight, and support I deeply appreciated.

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Abstract of Dissertation Presented to the Graduate School
of the University of Florida in Partial Fulfillment of
the Requirements for the Degree of Doctor of Philosophy

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December 1986

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The study examined alcohol consumption through the perspective of maximization theory. This perspective holds that an account of drinking includes not only constraints on access to alcohol consumption, but the availability of and constraints on access to other reinforcing behaviors as well. Accordingly, six non-alcoholic subjects were exposed individually to a choice situation in which drinking an alcohol beverage and game playing were the available behaviors. Subjects were required to earn (by button pressing) a fixed income of tokens which they were then permitted to use for purchase of either behavior. After stable responding was achieved, three subsequent changes were made in the price of game playing. The direction of price changes was dependent upon the extent of subject responsiveness to the preceding change as evidenced by elasticity estimates. Subjects were then exposed to two more conditions. In the first, subjects were given more tokens than they could spend. In the second, subjects were permitted to earn as many tokens as they wished. The price of drinking remained the same throughout the experiment. Subjects´ choice behavior was examined with respect to their willingness to give up game playing and to substitute (or complement) drinking as well as "other" behavior for the former. The results indicated that, consistent with maximization theory, subject´s responsiveness to changes in the availability of game playing was dependent upon individualized styles of substitution (or complementation) of drinking and "other" behavior with game playing. These styles were interpreted as an expression of pre-existing behavioral preference structures. Self report inventories were found to be useful in predicting changes in drinking behavior with changes in the availability of the other targeted reinforcing behavior--game playing. The two final experimental manipulations, which represented conditions of free responding, and responding under flexible income, were not predictive of responding under constraint.

CHAPTER I
INTRODUCTION

Behaviorally oriented alcohol research has been predominantly guided by neobehavioral learning theory (e.g., C. Hull, 1943). Within the neobehavioral tradition, an attempt has been made to identify alcohol as a reinforcer through an analysis of the contexts in which reinforcement occurs. A variety of internal states have been postulated as major contributors to the contexts in which alcohol is reinforcing (c.f. Berglas & Jones, 1978; Conger, 1956; Hull, 1981; Marlatt, 1976; McClelland, Davis, Kalin, & Wanner, 1972; Steele, Southwick, & Critchlow, 1981). From this point of view, alcohol consumption is or is not a reinforcing event dependent upon its impact on a hypothesized internal state of the organism (Hilgard & Bower, 1966). For example, alcohol has been defined as a reinforcer when its consumption reduces "tension," "cognitive dissonance," or "need for decreased self awareness" (c.f. Conger, 1956; Steele, Southwick, & Critchlow, 1981; J. Hull, 1981). In keeping with this perspective, neobehavioral alcohol research has focused on manipulation and control of the hypothetical states, (such as tension), deemed responsible for the extent to which alcohol is reinforcing. Unfortunately, the empirical support for any one internal state hypothesis is ambiguous; no particular internal state can be endorsed as an improvement over the others. Accordingly, no satisfactory accounts of normal or abusive alcohol consumption have evolved from this body of research (Vuchinich, 1982; Vuchinich & Tucker, 1983). Alternative conceptualizations of reinforcement have therefore been applied to drinking behavior. Among the alternatives, behavioral theories of choice appear promising (Vuchinich, 1982).

Like neobehavioral learning theories, behavioral theories of choice attempt to define reinforcers through an analysis of the contexts in which reinforcement occurs. However, behavioral theories of choice attempt to examine reinforcers in the context of the other available reinforcers and the constraints on access to both. This view holds that organisms value, or prefer, some reinforcers more than others (Rachlin, Battalio, Kagel, & Green, 1981). Because significant regularities have been found between behavior and reinforcers (e.g. deVilliers, 1977; Herrnstein, 1970), behavioral theories of choice emphasize overt behavior. Value, therefore, is measured as the amount of behavior allocated to gain access to a particular reinforcer. Behavioral allocation is a function of the constraints on access, or contingencies, associated with reinforcers (Rachlin, Battalio, Kagel, & Green, 1981). From the perspective of behavioral theories of choice, then, alcohol consumption can be defined as a reinforcer when it is valued, or preferred, in the context of other available reinforcers and the constraints on access to the former and the latter (Vuchinich & Tucker, 1983). Alcohol research rooted in this viewpoint focuses upon manipulation and control of the constraints on access to alcohol consumption, and the availability of as well as constraints on access to other reinforcers. Behavioral theories of choice do not necessarily offer a better conceptual explanation of alcohol consumption than do neobehavioral learning theories. However, the emphasis on overt behavior and behavior-behavior relationships may allow more fruitful research endeavors which, hopefully, will lead to a satisfactory, descriptive account of human alcohol consumption.

Vuchinich and Tucker (1983) have applied the conceptual framework of behavioral theories of choice to alcohol consumption. They exposed heavy to moderate social drinkers to a choice situation with two behavioral alternatives, one of which produced access to alcohol, the other produced access to money. Button presses registered points which were exchanged for either money or alcohol. Alcohol was made available immediately after the choice procedures. Money was made available in either $.02 or $.10 units at one of three levels of delay: 0, 2, or 8 weeks. The results indicated main effects for the delay and amount of money. Subjects in the $.02 condition preferred alcohol significantly more than subjects in the $.10 condition. Although the two delay conditions did not differ significantly from one another, subjects in both of these conditions preferred alcohol significantly more than subjects in no delay condition.

The Vuchinich and Tucker experiment demonstrates that constraints on access to money affected drinking behavior. These results suggest that the context in which alcohol consumption was found to be a reinforcer was dependent upon the availability of an alternative reinforcer and the constraints on access to that reinforcer. Clearly this is consistent with an account of alcohol consumption derived from behavioral theories of choice.

Behavioral theories of choice all evidence the similarities described above. Economic theories of choice form one subset of this literature. Borrowed from microeconomics, this molar view of behavior attempts to account directly for context (Rachlin, Battalio, Kagel, & Green, 1981), and contains concepts which are particularly appropriate for the study of alcohol consumption.

Economic theories of choice hold that behavioral commodities, or activities, have reinforcing value (Lea, 1978; Rachlin & Burkhard, 1978). Organisms allocate behavior among the available behavioral commodities such that they engage in the combination, or package, of commodities which maximizes value under that set of circumstances (Rachlin & Burkhard, 1978). The package combination chosen is a reflection of the organism´s preference structure. Within the preference structure, behavioral commodities are ordered with respect to value so that some behaviors have more status than others, i.e., some commodities are preferred over others. Preference structure is influenced by both heredity and learning (Rachlin, Battalio, Kagel, & Green, 1981). Given a variety of familial and learning backgrounds, preference structures may be highly individualized.

Some authors have suggested that conditions of free responding (i.e., there are no constraints on access to the available commodities) allow an examination of the value status of the available behavioral commodities, and therefore are predictive of responding under constraint (c.f. Premack, 1965; Rachlin, Battalio, Kagel, & Green, 1981). Others suggest that value status and predictions of responding under constraint can not be determined from one context (c.f. Hursh, 1980). Instead, changes in responding must be observed under more than one context.

The extent of the change in responding with a change in context is referred to as elasticity.

Elasticity is a concept which provides a behavioral yardstick for the study of alcohol consumption. It describes the relationship between a behavior and a change in context wrought by environmental changes in access to that behavior. Changes in access to a behavioral commodity such as alcohol consumption can produce elastic, inelastic, or unitary changes in responding. An elastic change in responding is one that is greater than the extent of the corresponding change in access to the behavior (Hursh, 1980; Leftwich, 1966). Therefore, an individual who readily decreases his alcohol consumption when alcohol becomes mildly difficult to obtain, demonstrates elastic responding. An inelastic change in responding is one that is less than the extent of the corresponding change in access (Hursh, 1980; Leftwich, 1966). An individual who continues to drink the same amount even though alcohol has become very difficult to obtain, demonstrates inelastic responding. A unitary change in responding is one that is neither elastic nor inelastic, but equiproportional to the extent of the corresponding change in access (Hursh, 1980; Leftwich, 1966). An individual who modifies his alcohol consumption proportionally to his difficulty in obtaining it, demonstrates unitary responding.

The elasticity of alcohol consumption with changes in access has been investigated by economists. In general, the literature suggests that changes in access to public outlets has a minimal effect on consumption rates, suggesting that alcohol consumption is inelastic. For example, Parker, Wolz and Harford (1978) studied changes in alcohol consumption with alterations in alcohol availability in the United States. They found that alcohol availability, as measured by outlet rates, has a minimal effect on consumption. The results suggest that alcohol consumption is inelastic with respect to accessibility of outlets.

For another example, a study by Williams (1972) indicated similar conclusions. In Victoria, United Kingdom, closing hours in hotels serving alcohol were extended from 6:00 p.m. to 10:00 p.m. in 1966. During the period from 1958 to 1969, changes in consumption with this change in accessibility were small, slow to occur, and very inelastic.

Data from on-premise outlets and tavern drinking patterns, however, suggest that there may be a heavy drinking segment of the population for whom alcohol consumption is more elastic than that of the population as a whole. For example, Harford, Parker, Pautler and Wolz (1979) examined the relationship between alcoholism rates and the number of on-premise drinking outlets (such as bars and taverns) in the United States. They found a significant relationship, suggesting that changes in the availability of this type of public drinking outlet may result in elastic changes in individual alcohol consumption rates. In support of their conclusions, Nusbaumer, Mauss and Pearson (1982) report that the frequency of tavern and bar patronage is the single most important predictor of excessive drinking in the United States.

Changes in access to alcohol consumption can be effected by price as well as by outlet availability. As price increases relative to income, the amount of alcohol which can be purchased is constrained. There is some suggestion within the economic literature that changes in price effect greater changes in consumption than do changes in outlet availability. For example, Popham, Schmidt and de Lint (1975) compared the effects of alcoholic beverage access and price relative to income on alcohol consumption rates. They concluded that price changes were responsible for most of the consumption variance. Their results suggest that price may be a more salient variable than outlet availability in determining alcohol consumption rates. In similar studies, Smart (1977) and de Lint and Schmidt (1971) drew identical conclusions.

Although price changes appear to affect alcohol consumption more than do changes in outlet availability, the literature indicates that, in general, alcohol consumption is inelastic with respect to price. For example, Levy and Sheflin (1982) examined variations in per capita absolute alcohol consumption with changes in price relative to income in the United States from 1940 to 1980. Alcohol consumption was found to be inelastic. However, Cook (1982) has concluded, as did Harford et al. (1979), that for a heavy drinking segment of the population alcohol consumption is more elastic than it is for the population as a whole. He found that in the United States from 1960 to 1974 alcohol consumption and cirrhosis mortality rates varied negatively with price increases.

In addition to what appears to be differences in the elasticity of alcohol consumption among heavy drinkers and the rest of the population, there appear to be differences in elasticity for consumption of various beverage types. Ornstein (1980), for example, reviewed the existing literature on price elasticity and beverage type and concluded that beer is inelastic, spirits are elastic, and wine is indeterminate. Maynard and Kennan (1981) conducted a similar review and concluded that beer is inelastic, spirits are elastic, and wine is unity.

Some of the psychologically oriented literature has investigated the effects of price manipulations on alcohol consumption. Strickler, Dobbs and Maxwell (1979), for example, exposed 16 male volunteers from an undergraduate psychology class to both laboratory and barroom settings. Subjects reported beer as their preferred alcohol beverage, and at least two drinking occasions per week. Although all subjects were instructed to bring at least $3.00 with them, eight subjects in each setting received free beer. The remaining eight subjects paid $.70 for each beer. Subjects receiving free beer in either setting drank significantly more than paying subjects. Close examination of the data, however, reveals that paying subjects did not demonstrate an increase in drinking over non-paying subjects which was greater than the increase in price from $0.00 to $.70. The results therefore indicate inelasticity. This is consistent with conclusions by Ornstein (1980) and Maynard and Kennan (1981) who found beer consumption to be inelastic. The results also showed that subjects in the barroom drank significantly more than subjects in the laboratory; a result consistent with findings reported by Harford et al. (1979) who concluded that access to a barroom setting is an important consumption variable.

Babor, Mendelson, Greenberg and Kuehnle (1978), for another example, paid 34 male subjects, recruited through advertising, to live on an inpatient ward for 30 days.

During this time period, spirits and beer were available for 20 days. Each subject was given an operant manipulandum on which points could be accumulated and then exchanged for money. One ounce of spirits or 12 ounces of beer were priced at $.50. For 16 subjects, however, drinks were only $.25 during "happy hour" (between 2:00 p.m. and 5:00 p.m.). All subjects exposed to the "happy hour" condition drank significantly more than the non-happy hour subjects. The authors then divided subjects into "heavy" and "casual" drinker categories. Heavy drinkers were defined as those subjects who drank more than the ethanol equivalent of two ounces of spirits per day and had five or more episodes of drunkenness per month prior to the investigation. Casual drinkers were defined as those subjects who drank less and had fewer episodes of drunkenness per month prior to the investigation than the heavy drinkers. An inspection of the data reveals that the differences in alcohol consumption between happy hour and non-happy hour heavy drinkers were inelastic with respect to the change in price. The differences in alcohol consumption between happy hour and non-happy hour casual drinkers were elastic with respect to the change in price. These results contrast with those reported by Harford et al. (1979) and Cook (1982) who concluded the opposite relationship between drinker categories and the elasticity of alcohol consumption.

For a third example, Babor, Mendelson, Uhly and Souza (1980) evaluated drinking patterns of 8 female and 8 male regular bar patrons over a 12 day period. Observation took place from 3:00 p.m. - 2:00 a.m. daily. Only four of the patrons observed attended "happy hours," (3:00 p.m. - 5:00 p.m.), during which all drink prices were reduced by $.20. All subjects frequented the bar three to four days a week. The results indicated that subjects attending happy hour drank significantly more than those who did not. An inspection of the data reveals that the differences in alcohol consumption between happy hour and non-happy hour subjects were elastic with respect to the changes in price. Similarly, the changes in alcohol consumption for happy hour subjects during and after happy8 hour were elastic with respect to the changes in price. None of the subjects appear to have been heavy drinkers. The results therefore support those reported by Babor et al. (1978).

For a fourth example, Bigelow and Liebson (1972) provided two chronic male alcoholic inpatient volunteers with an opportunity to earn drinks comprised of one ounce of ethanol (95 proof) and two ounces of orange juice. A maximum of 24 drinks were available daily in exchange for points accumulated on an operant manipulandum. For three days drinks could be purchased at a price of 100 points, for four days at a price of 1,000 points, for four days at a price of 3,000 points, and for three days at a price of 5,000 points. The results indicated that both subjects drank significantly less as the price increased. Careful evaluation of the data reveals inelastic changes in alcohol consumption for both subjects with the first two price changes. As price increased from 3,000 to 5,000 points, however, the changes in alcohol consumption for both subjects were elastic. The alteration in elasticity suggests that, for the two subjects in the experiment, alcohol consumption tended to be inelastic, except at very high prices where it tended to be elastic. These interesting findings suggest a more in depth picture of heavy drinker consumption patterns than that depicted by Harford et al. (1979) and Cook (1982) who concluded that heavy drinkers evidence elastic consumption.

As has been pointed out in some instances above, findings from the psychological literature sometimes contrast with those presented from the economics literature. In large part, these discrepancies may be due to fundamental differences between the two approaches which create interpretive problems. Behavioral theories of choice are intended to describe the behavior of individuals or small groups of individuals. In contrast, the economic approach is intended to describe trends in a population; hence, data from large numbers of people are aggregated. Thus, conclusions can be drawn at the level of population or subpopulation trends, but not at the individual level. In addition, behavioral theories of choice measure consumption variables as behavioral engagement. In economics, consumption is measured via sales data. No attempt is made to differentiate between the purchase of, and the actual behavioral consumption of alcohol. These differences engender cautious interpretation of the economics literature from a behavioral theories of choice perspective.

In spite of these problems, however, the data from both the psychology and economics literatures indicate that the elasticity of alcohol consumption is influenced by changes in price, setting, and beverage type. This suggests that an examination of the value status of drinking and predictions of drinking patterns should take into account these contextual variables.

In addition to dictating the value status of behavioral commodities, preference structures allow some behaviors to be substituted for others. Constraints on behavior, such as schedules and prices, alter contexts by restricting access to some of the available behavioral commodities (Rachlin, Kagel, & Green, 1981). As one commodity becomes difficult to obtain, the preference structure might permit this commodity to be replaced by another relatively substitutable commodity (Hursh, 1980; Rachlin, Kagel, & Battalio, 1980). The availability of substitutes encourages the organism to change its responding with changes in context. In this way, substitution results in an increased elasticity of responding (Hursh, 1980; Leftwich, 1966). In contrast, however, the preference structure also permits the value of some commodities to be maintained only when they exist in proportion with other commodities (Rachlin, Kagel, & Battalio, 1980). This proportional relationship is termed complementation (Leftwich, 1966; Rachlin, Kagel, & Battalio, 1980). Where complementation describes the relationship between commodities, restrictions on access to one commodity results in decreased engagement in another relatively complementary commodity. The existence of complementary relationships between commodities encourages the organism to change its responding little with changes in context. In this way, complementation results in decreased elasticity of responding (Hursh, 1980; Leftwich, 1966). The extent of substitution or complementation between commodities with a change in context is referred to as cross elasticity.

There are indications, within the psychological literature, that cross elastic relationships occur between drinking and other behavioral commodities. For instance, the consumption of other substances as a complement to, or a substitute for, alcohol consumption has occasionally been reported. Mello and Mendelson (1972) found that alcohol consumption would substitute for cigarette smoking with problem drinkers. Twenty-three alcoholic male inpatients with a history of spree drinking (consuming about one quart of whiskey per day) served as subjects. Each subject was given an operant manipulandum on which points could be registered and then exchanged for tokens. In the first experimental phase, tokens could be used to purchase: cigarettes only for 10 days, cigarettes or alcohol for the succeeding 30 days, and then cigarettes only again for 10 days. The results showed that when alcohol was available, subjects did not purchase cigarettes. The second experimental phase replicated the first, with the exception that when alcohol was available, it could be purchased with freely provided, non-operant contingent tokens. As was the case with the first phase, the results showed that subjects did not purchase cigarettes when alcohol was available. The third experimental phase also replicated the first, but this time tokens were provided for both alcohol and cigarettes without the operant contingency. The results showed that cigarette consumption decreased markedly following alcohol availability. It seems that cigarettes were substituted for by alcohol, but alcohol was not substituted for by cigarettes.

Mozdzierz, Goetz, Semyck, DeVito and Davis (1981) examined the relationship between coffee drinking and alcohol consumption. Sixty-four inpatient volunteers from a Veterans Administration alcohol treatment program served as subjects. Coffee was continuously available, and alcohol unavailable, following admission to the program. The results indicated that during subsequent weeks in the hospital, the inpatients progressively drank significantly more coffee per day. The authors concluded that the subjects drank about three times as much coffee as the estimated "average American." These findings suggest that when alcohol is made unavailable to this population, coffee can become a substitute.

Sokolow, Welte, Hynes and Lyons (1981) found relationships between alcohol consumption and the consumption of illicit substances. Self report data were obtained for 1,340 alcoholics who had been discharged from an inpatient drug treatment facility. Pre and post treatment as well as two follow up surveys were conducted. Although all categories of drug usage (including alcohol) showed decreases after treatment, sedative, barbiturate, narcotic, amphetamine and hallucinogen use increased over time as marijuana and alcohol use decreased. This suggests that alcohol and marijuana consumption are complements, while other illicit drugs are alcohol substitutes.

The conclusions of Sokolow et al. (1981) are borne out, to some extent, by Simpson and Lloyd (1981). Self report data on 2,295 drug abuse program clients were collected following treatment completion. Within subject analysis showed no significant relationship between alcohol and nonopiate drug use, a complementary relationship between marijuana and alcohol use, and a substitutive relationship between opiate and alcohol use. The results again indicate a complementary relationship between marijuana and alcohol consumption. However, a substitutionary relationship is confirmed only for alcohol and opiate consumption.

Substitutive and complementary relationships do, therefore, seem to occur between alcohol consumption and the consumption of other substances. Relationships may also occur between other types of behavioral commodities and drinking. One such commodity may be social interaction. Economic theories of choice hold that behavioral commodities, not objects, have reinforcing value. Because social interaction is comprised of a group of behaviors which can be described as a behavioral class, it is reasonable to assume that social interaction can be considered as a behavioral commodity. As such, it is also reasonable to assume that social interaction might substitute or complement alcohol consumption.

Some studies indicate that a relationship does exist between drinking and socializing. For example, Griffiths, Bigelow and Liebson (1975) report an investigation which suggests that drinking and socializing are complements. Four male chronic alcoholic inpatients referred from a hospital emergency room were given a dichotomous choice between a small amount of money and 20 minutes of socializing. Amounts of money were individually adjusted such that each subject chose socializing only 50% of trials. Eight drinks per subject consisting of alcohol and orange juice alone were then self administered. The average percent of choosing socializing over money following alcohol administration was significantly greater than that found following the administration of orange juice alone. Social interaction, therefore, appears to be more reinforcing in conjunction with alcohol consumption, suggesting that the two behaviors are complementary.

Griffiths, Bigelow and Liebson (1977), for another example, also report findings which suggest a complementary relationship between drinking and socializing. Seventeen drinks (alcohol and orange juice) were made available daily to each of 14 male, chronic, "gamma," inpatient alcoholics referred from a hospital emergency room. During baseline conditions, subjects were free to participate in social interaction and ward activities. Three experimental conditions were then sequentially imposed: social time out, activity time out, and social/activity time out. In each respective condition, receipt of alcohol resulted in a 40 minute prohibition of socializing, activity participation, or both. All three contingencies resulted in a significant decrease in alcohol consumption. These results suggest that alcohol consumption was less valued when subjects were prohibited from socializing and/or participating in activities while drinking. Alcohol consumption therefore appears to have had a complementary relationship with activity participation and socializing for these subjects.

Griffiths, Bigelow and Liebson (1974), for a third example, similarly present evidence of complementation occurring between social interaction and alcohol consumption. Six male, chronic, "gamma," inpatient alcoholics referred from a hospital emergency room were each given the opportunity to consume 17 drinks (alcohol and orange juice) daily. During the baseline phase of the experiment, subjects were free to socialize and participate in ward activities. A time out contingency was then imposed in which socializing was prohibited for 40 minutes upon receipt of each drink. The baseline and time out manipulations were then crossed with three alterations in available privileges: full, no TV while drinking, and no TV or reading materials while drinking. The results indicated main effects for prohibition of social interaction. Privilege restriction alone had little or no effect on alcohol consumption, while any condition involving social interaction time out resulted in significantly reduced drinking. Once again, alcohol consumption seems to have been less valued when subjects were prevented from socializing while drinking, i.e., socializing and drinking formed a complementary relationship.

Clinically, substitution and complementation are important concepts. Assuming that substitutes exist for alcohol consumption, it might be possible to increase substitute availability or to remove some of the constraints on access to substitutes. These manipulations could conceivably discourage alcohol consumption by encouraging substitutive engagement. For example, if social interaction was a substitute for alcohol consumption for an individual, he could be encouraged to increase social interaction. Possible interventions might include social skills training, assertiveness training, and prearranged participation in social activities. In the event that complements exist for alcohol consumption, it might be possible to decrease complement availability or to impose constraints on access to complements. These manipulations might also reduce alcohol consumption. For example, if watching television was a complement for drinking for an individual, he could be encouraged to decrease television watching. Possible interventions might involve occupational and recreational therapy. Before any clinical applications can be seriously considered, however, experimental spadework must demonstrate the applicability of economic theories of choice to alcohol consumption. This study represents an attempt to provide empirical groundwork for further research through an examination of the relationships between video game playing and alcohol consumption.

Economic theories of choice hold that behavioral commodities, not objects, have reinforcing value. As a class of behavior which naturalistic observation suggests is reinforcing in some circumstances, the assumptive proposition that video game playing[1] is a behavioral commodity is reasonable. Viewed as a commodity, video game playing may therefore function as a substitute, or complement, for alcohol consumption. In a single subject design, changes in the quantity of behavior allocated to video game playing were compared to corresponding changes in the quantity of behavior allocated to alcohol consumption. Behavioral allocation between these two commodities was assessed primarily via duration. The use of time as a measure of behavioral commodities is justifiable. Time spent responding is as accurate and descriptive as a variety of other measures, such as rate and frequency. In addition, time has the advantage of allowing a variety of behaviors with variable topographies, (like video game playing and drinking), to be directly compared (Baum & Rachlin, 1969; Premack, 1965).

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[1] Although its use as a reinforcer has not been specifically tested to date, the reinforcing value of video game playing has been accepted in the field of education (c.f. Bowman & Rotter, 1983).

Single subject designs rely upon multiple measurements on a few individuals. The data obtained are typically interpreted for each individual via visual inspection. This approach allows for each individual to serve as his own control and for a fine grain analysis of his behavior. Questions of generalizability are addressed through experimental replication. In contrast, group designs rely upon a few measurements on many individuals. The data obtained are typically interpreted as group trends via complicated statistical maneuvers. This approach usually requires a control group and allows only gross comparisons between groups. Generalizability is addressed by the use of large numbers of subjects and sampling procedures (Johnston & Pennypacker, 1980). The single subject design was chosen over a group design for this experiment primarily because of the level of fine grain analysis it afforded. It was hoped that the detailed information made available by the design would lend itself easily to specific suggestions for a systematic program of research. It is anticipated that such an investigative program will allow greater prediction and control of individual behavior than is possible to pursue through an analysis of group trends.

In the experimental setting, both alcohol consumption and video game playing were made available for a price--a token price. It has been suggested within economic theories of choice that a) income must be fixed such that subjects must budget expenditures, and b) two distinct transactions exist with respect to price--working to obtain a medium of exchange, and exchanging that medium for commodities (Castro & Weingarten, 1970). Accordingly, subjects were required to earn, via a fixed ratio 100 (FR 100) schedule, a fixed number of tokens which were exchangeable for the two available commodities. The first four phases of the experiment involve changes in context which restrict access to video game playing. This was accomplished by changing the price of game playing while keeping that of alcohol consumption constant. Phase changes were instituted on the basis of the elasticity of responding to the previous change in context. The manipulation was intended: 1) to elucidate the value, or preference, status of the two activities by observing responding under more than one set of circumstances, and 2) to encourage substitution or complementation of alcohol consumption with game playing.

Some subjects were also exposed to two additional phases which were analogous to free responding. In the first of these additional phases, Phase FR, subjects were given an unlimited number of tokens for which they were not required to work. Preferences among the two commodities displayed under this condition were compared with choice behavior displayed under the constraints imposed in the first four phases. The purpose of this manipulation was to determine whether preferences and predictions of responding under constraint could be determined from a free responding context.

In the second phase analogous to free responding, Phase FW, subjects were required to earn tokens as they were in the first four phases. However, no upper limit was placed on income. The purpose of this last manipulation was to assess whether, given unlimited access to tokens, the addition of an operant requirement for attainment of the medium of exchange would produce choice behavior which was different from that observed in Phase FR. A second purpose was to observe whether given the same price limitations on access to the commodities, subjects preferred an income different from the fixed income imposed in the first four phases.

CHAPTER II
METHOD

Pilot Study

A pilot study was conducted in order to determine the feasibility of the main experiment. The pragmatic issues it addressed were the ability of the video games to engage the subject´s behavior, inter-rater reliability, the possible effect of game preference on behavior, and the overall stability of subject´s behavior between sessions. In each case, the results of the Pilot Study indicated that it was legitimate to proceed with the main experiment. The Pilot Study is presented in detail in Appendix A.

Main Experiment

Experimenters

All initial experimental sessions were conducted by the author, who also administered all questionnaires. Other experimental sessions were conducted by the author and/or one of three trained undergraduate assistants.

Subjects

Six male college students whose ages ranged from 21 to 29 served as subjects. None of these subjects had participated in the Pilot Study. They were recruited via poster or newspaper advertisements (copies of the advertisements are included in Appendix B). Each subject a) stated that he had never received psychological counseling or therapy, b) was a regular, moderate social drinker with no history of alcohol problems as assessed by standardized psychometric measures of drinking behavior[1] (copies of the questionnaires are included in Appendix B), c) stated that he had no psychological or medical condition or was taking any medication that precluded his consumption of moderate amounts of an alcoholic beverage, d) agreed to schedule his experimental sessions such that four hours elapsed before the end of each session and the beginning of his next scheduled activity, e) asserted in writing that he would not drive a car or operate other machinery for at least four hours after each experimental session, f) asserted in writing that he would arrange for alternative transportation to and from the laboratory, g) asserted in writing that he would not consume alcohol or other drugs prior to the experimental sessions on the day of his participation, h) agreed to remain in the laboratory until his blood alcohol level reached .05% or less, and i) expressed a liking for video games as well as vodka and orange juice. Subjects received $3.00 per hour for each hour of their experimental participation and were paid regardless of their performance in the experimental sessions.

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[1] The questionnaire package was composed of a modified version of the Drinking Practices Questionnaire (Cahalan, Cisin, & Crossley, 1969), the brief form of the Michigan Alcoholism Screening Test (Pokorny, Miller, & Kaplan, 1972), and the Alcohol Use Inventory (Mehrabian & Russell, 1978). Habitual abstainers as well as any subject demonstrating drinking problems, as assessed by any questionnaire, were excluded from the study.

Experimental Setting

All experimental sessions were conducted within a space containing three distinct activity areas: a "work" area, a "drink" area, and a "game" area.

The "work" area was equipped with a table and chair. Secured to the table was an operant manipulandum, a counter, and a clock.

The "drink" area was similarly equipped with a table and chair. A token receptacle and an ashtray were located on the table. A delivery window placed in a nearby wall allowed for each access to drinks (20 ml vodka, 80 ml orange juice; approximately one-half of a standard mixed drink). The same wall contained two one-way mirrors for the use of the concealed observer(s).

The "game" area also contained a table and chair. A color television (displaying the video game), a joy stick (for game operation), and another token receptacle were located on the table. One of two video games was displayed on the television at all times.

Procedures

Each subject participated in one-hour sessions on an individual basis. Prior to involvement in the first session, subjects a) received detailed instructions about the experimental procedures and requirements, b) completed the Video Game Playing Questionnaire (a copy of the questionnaire is included in Appendix B), c) completed the drinking history questionnaires, d) read and signed the Informed Consent Form following discussion of its elements with the primary investigator (a copy of the Informed Consent Form is included in Appendix B), e) were asked if they had ever received psychological counseling or therapy, g) were asked to read the instruction booklets for the two pre-programmed video games available in the experiment. Copies of the instruction booklets (which include a description of the games) are included in Appendix C. Prior to involvement in each session, subjects were asked if they had arranged for alternative transportation to and from the laboratory, and were administered a breath test to ensure that their blood alcohol level (BAL) was zero. Following each experimental session, subjects were again administered a breath test.

Subjects were permitted to leave the experimental space only after their BALs reached .05% or less. BALs were assessed at 10 minute intervals, at least twice, to ensure that they were not increasing.

Immediately before the onset of the first one hour session, subjects were required to engage in button pressing to earn tokens on a fixed ratio 100 schedule. A counter within view of the subject displayed the number of tokens earned. When the counter displayed 10, the subjects were told to stop and were given 10 tokens. They were then told that one token could be exchanged for either one alcohol drink--20 ml (.677 oz) 80 proof vodka and 80 ml (2.711 oz) orange juice--or 6 minutes of playing time. They were asked to drink only while seated in the drink area chair and told that they would not be permitted to take the drink with them to either the work area or the game area. They were informed, however, that they could switch areas at any time and that the game playing time would be accurately reserved. When playing the video game, their game would be put on hold if their six minutes had elapsed, and would not be released until they had paid another token. The clock was then set for one hour, and they were told that they would be required to remain in the experimental space for the entire hour regardless of whether they had utilized all of their tokens before that time. Tokens could be spent only in sessions at which they were earned and could not be accumulated across sessions. Subjects were informed that no requirements that they either drink or play existed at any time. These activities were simply being made available if they chose to purchase them. The subject was then asked which of the two games he wished to play, if appropriate was asked for which level (0-15) he wished the game programmed, and was informed that he could change levels and/or games at any time by notifying the experimenter. Transcripts of instructions given to subjects are included in Appendix D. The session then began and proceeded as described. No data were accumulated for this first session; it was utilized solely for the purpose of orienting the subject to the rules and procedures of the sessions to follow.

Phase 1

The second one hour session proceeded exactly as did the first with the exception that dependent measure data were collected as described below.

1) The total engagement in game playing was timed. Engagement in game playing was defined as the subject seated in the game area in front of the video display with the game turned on, (i.e., not on hold awaiting token payment).

2) The games played, (as defined by the game program), were counted.

3) Each game played was timed.

4) The tokens spent on game playing were counted.

5) The total period spent seated in the drink area with alcoholic beverage in the glass was timed.

6) The tokens spent on drinks were counted.

7) The quantity of alcohol consumed was measured.

8) Sip episodes were counted. Sip episodes were defined as occurring from the time the subject placed the beverage glass in contact with his lips until the glass was removed from his lips.

9) The total period spent sipping was timed.

10) Sips per drink were counted.

11) The total period spent sipping per drink was timed.

12) The total engagement in work was timed. Engagement in work was defined as the subject seated in the work area in front of the operant manipulandum with the device turned on, (i.e., button presses would result in the subject´s performance being displayed on the counter).

13) Blood alcohol level (BAL) was assessed.

14) "Area other" was calculated. "Area other" was defined as drink area time (see #5) plus game area time (see #1) subtracted from the one hour session time.

15) "Sip other" was calculated. "Sip other" was defined as the total time spent sipping (see #9) plus game area time (see #1) subtracted from the one hour session time.

16) "Stereotypic other" behavior was timed. "Stereotypic other" was defined as the total time spent in "other than" behavior which could be observed by the experimenter.[2]

The entire second session procedure was then repeated until the subject demonstrated stable responding for at least three successive sessions. Stable responding was defined as no deviation greater than one unit of behavior among three successive sessions on game playing. The unit of behavior for game playing remained throughout the experiment at six minutes of game playing time. In Phase 1, one unit of game playing time was priced at one token. Sessions were scheduled at least 24 hours apart. If at all possible, sessions were scheduled at regular days and times.

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[2] This category was loosely defined and somewhat subjective as the "other than" behaviors varied between subjects as well as sessions. Nevertheless, "other than" behavior was measured via observation and subtraction as some authors have suggested that this is an important behavioral determinant (c.f. Rachlin & Burkhard, 1978).

Phase 2

Phase 2 was conducted exactly as was Phase 1, with the exception that the price of one six minute unit of game playing time was raised to three tokens. Subjects were informed of the price change. The price of one drink remained in this, and all other phases, at one token.

Phase 3

Before beginning Phase 3, for each subject, the elasticity coefficient of one unit of game playing behavior (six minutes) was calculated for the change in price from Phase 1 (one token) to Phase 2 (three tokens). The elasticity coefficient and methods for computing it are detailed in the Results section. At this point, suffice it to say that a coefficient of greater than one indicates elastic responding. This means that the subject reduced his expenditure on game playing under the higher price and did not attempt to conserve his level of game playing under lower price conditions. Elastic responding thus involves a reallocation of income away from game playing when the price is increased. Conversely, a coefficient of less than one indicates inelastic responding. This means that the subject increased his expenditure on game playing under the higher price in an attempt to conserve his level of game playing under lower price conditions. Inelastic responding thus involves an increase in the allocation of income toward game playing when the price is increased. A coefficient of one indicates unitary responding. This means that the subject reduced his game playing under the higher price in an attempt to conserve his level of expenditure under lower price conditions. Unitary responding therefore involves no change in the allocation of income toward game playing, and a proportional decrease in game playing when the price is increased. In this way, unitary responding forms the boundary condition between elastic and inelastic responding.

On the basis of the elasticity coefficient, a decision was made whether to raise or lower the price of one unit of game playing for each subject. If the subject´s coefficient showed elasticity (>1) the price was lowered to two tokens. Only one subject experienced a decrease in token price per unit of game playing, Subject 11. If the coefficient showed inelasticity (<1) or was close to unity (=1), the price was raised to five tokens. Five subjects were exposed to an increase in token price per unit of game playing, Subjects 6, 14, 16, 18 and 19. The purpose of this manipulation was to encourage subjects to demonstrate a range of elasticities for game playing. As price increases, and approaches total income, responding is likely to become more elastic. As price decreases until it represents only a fraction of total income, responding is likely to become more inelastic. As the responsiveness of game playing to changes in context becomes more elastic, substitution of alcohol consumption for game playing is likely to occur, provided that alcohol consumption and game playing function as substitutes for one another. Once the decision was made to raise or lower the price of one unit of game playing, the sessions for Phase 3 were conducted exactly as were those of Phase 1 with the exception of the price change. Subjects were informed of the price change to either two or five tokens. They were not informed of the reason behind the change.

Phase 4

Preceding Phase 4, elasticity coefficients were again calculated for each subject as they were in Phase 3. However, this coefficient calculation involved the change in price from Phase 2 (three tokens) to Phase 3 (either two tokens or five tokens). Again, on the basis of the elasticity coefficient, a decision was made to either raise or lower the price of one unit of game playing. If the subject had demonstrated elasticity with the previous price changes, an attempt was made to elicit an inelastic and/or unitary change by lowering the price. This occurred in only one instance. Subject 11´s price was lowered from two tokens in Phase 3 to one and one half tokens in Phase 4. He was permitted to "get change" for tokens whenever he wished. One token was exchanged for two "half tokens," i.e., two tokens of a different color. If the subject had demonstrated inelasticity or unity only with the previous price changes, an attempt was made to elicit an elastic change by raising the price. For three subjects, Subjects 6, 18, and 19, the price was raised to 10 tokens in an attempt to force a dichotomous choice which would encourage an increase in alcohol consumption. For two subjects, Subjects 14 and 16, the price was raised to eight tokens because their pattern of expenditure suggested that although they would spend the maximum possible amount on game playing, they would also spend any remaining or extra tokens on alcohol consumption. Once the decision was made regarding the price of game playing units, the sessions for Phase 4 were conducted exactly as were those of Phase 1 with the exception of the price change. Subjects were informed of the price change to one and one half, ten, or eight tokens. They were not informed of the reason behind the change. Transcripts of instructions given to subjects in Phases 2 through 4 are included in Appendix D.

Free Responding Phase

The Free Responding Phase was conducted exactly as was Phase 1 with the exception that subjects were given more tokens than they could possibly spend (60 tokens) without having to execute the operant task. Only five of the six subjects who participated in Phases 1 through 4 participated in this phase, Subjects 6, 11, 14, 16, and 19. The purpose of this phase was to examine subject preferences in a condition analogous to free responding. Rachlin, Battalia, Kagel, and Green (1981) have suggested that behavior observed in this unconstrained condition may predict behavior under constraint, although this must be empirically determined. Transcripts of instructions given to subjects in the Free Responding Phase are included in Appendix D.

Free Work Phase

The Free Work Phase was conducted exactly as was Phase 1 with the exception that subjects were permitted to button press for as many or as few tokens as they wished at any time during the session. During the time subjects were button pressing, the clock was stopped so that the one hour session time did not include button pressing time. Only four of the subjects who participated in all of the preceding phases participated in this phase, Subjects 6, 11, 16, and 19. The Free Work Phase allowed comparison with the Free Responding Phase for examination of the effect of the operant contingency for attainment of the medium of exchange (button pressing for tokens) for expenditure. By some, the relationship has been considered important (c.f., Castro & Weingarten, 1970). It also allowed comparison with Phase 1 for an examination of the differences in expenditure between experimenter determined, fixed income (10 tokens), and subject determined, unlimited income. Transcripts of instructions given to subjects in the Free Work Phase are included in Appendix D.

CHAPTER III
RESULTS

The results of this experiment are summarized in Figures 3-1 to 3-57 and in Tables 3-1 to 3-9. First, information about the procedures, inter-rater reliability, and subjects´ responses to questionnaires are presented. Then, subjects´ token expenditures and activity purchases are summarized, and their game playing, drinking, and "stereotypic other" behavior examined. Next, a discussion follows of the relationships between game playing, drinking, as well as "other" behavior, and of the own price elasticity of game playing. Finally, subjects´ choices in the Free Responding and Free Work Phases are evaluated by a comparison with choices made in Phases 1 through 4 and Phase 1, respectively. Wherever it has seemed to serve clarity, the results have been conceptually clustered under a major heading. Little interpretable information was yielded by three of the measures: work area duration, number of games played, and blood alcohol level. For this reason, they have been summarized in Appendix E.

Table 3-1. Number of Sessions and Price of Game Playing per Phase, per Subject.

Subject	Phase	Number of Sessions	Price of Game Playing
6	1	7	1
	2	3	3
	3	8	5
	4	3	10
	FR	3	1
	FW	4	1
11	1	4	1
	2	6	3
	3	9	2
	4	13	1.5
	FR	3	1
	FW	7	1
14	1	7	1
	2	4	3
	3	5	5
	4	3	8
	FR	3	1
	FW	-	-
16	1	8	1
	2	9	3
	3	4	5
	4	8	8
	FR	7	1
	FW	3	1
18	1	7	1
	2	6	3
	3	9	5
	4	9	10
	FR	-	-
	FW	-	-
19	1	4	1
	2	3	3
	3	3	5
	4	3	10
	FR	3	1
	FW	3	1

Table 3-2. Percent Agreement--Primary Investigator with Each Assistant.

Measure	Assistant 1	 2	 3
Total duration of game playing	99%	90%	99%
Number of games played	100%	100%	100%
Duration of playing for each area	99%	99%	100%
Total duration in the drink area	99%	98%	99%
Total sip frequency	99%	100%	100%
Total duration of sipping	96%	98%	96%
Mean sip frequency per drink	98%	100%	100%
Mean sip duration per drink	97%	89%	99%
Total duration in the work area	99%	99%	99%
Total duration of "other than" behavior: session time - (total duration in the drink area + total duration of game playing)	98%	99%	99%
Total duration of "other than" behavior: session time - (total duration of sipping + total duration of game playing)	99%	98%	99%

Table 3-3. Questionnaire Data.

Subject	Drinking Practices Questionnaire*	Alcohol Use Inventory**	Video Game Questionnaire
6	Moderate (Mid)	8	12
11	Moderate (Hi)	25	19
14	Heavy (Lo)	19	25
16	Heavy (Lo)	19	19
18	Heavy (Lo)	18	13
19	Light (Mid)	7	20

*Calahan, Cisin, & Crossley, 1969
**Mehrabian & Russell, 1978

Table 3-4. Comparison of Scores on the Alcohol Use Inventory and the Video Game Questionnaire.

Subject	Alcohol Use Inventory Z Scores	Video Games Questionnaire Z Scores	Z Score Differences
19	-1.40	.45	-1.85
14	.47	1.59	-1.12
6	-1.24	-1.37	.13
16	.47	.23	.24
11	1.40	.23	1.17
18	.31	-1.14	1.45

Table 3-5. Number of Games, Number of Sips, Sip Duration, and Drink Area Duration Purchased per Token.

Subject	Phase	Games per Token	Sips per Token	Sip Duration per Token*	Drink Area Duration per Token*
6	1	4.0	5.5	10.7	61.0
	2	.7	4.0	10.4	36.0
	3	.4	7.0	10.0	108.0
	4	.3	---	----	-----
	FR	2.5	---	----	-----
	FW	1.5	4.5	13.0	58.0
11	1	2.3	---	----	-----
	2	1.2	4.9	9.4	419.6
	3	1.3	5.6	11.5	399.5
	4	3.0	5.9	13.4	492.8
	FR	6.8	4.3	12.0	316.0
	FW	4.9	4.3	10.6	163.8
14	1	4.0	6.7	14.0	84.8
	2	.8	7.3	11.9	199.6
	3	.6	6.6	18.0	155.4
	4	.3	2.6	6.8	41.6
	FR	2.6	7.0	13.0	130.5
	FW	---	---	----	-----
16	1	2.5	5.2	10.4	181.2
	2	.6	5.0	11.7	196.9
	3	.3	7.1	12.4	102.0
	4	.4	4.2	11.9	127.3
	FR	1.4	3.8	8.6	46.4
	FW	1.7	1.0	5.0	11.1
18	1	6.0	6.8	13.6	159.5
	2	1.7	8.0	17.2	328.0
	3	1.3	6.0	13.0	331.1
	4	.5	6.9	16.0	536.2
	FR	---	---	----	-----
	FW	---	---	----	-----
19	1	3.1	7.0	10.8	121.0
	2	1.5	---	----	-----
	3	.6	---	----	-----
	4	.2	---	----	-----
	FR	2.5	---	----	-----
	FW	2.8	---	----	-----

*in seconds

Table 3-6. Cross Elasticity Estimates Comparing the Price of Game Playing with Drink Area Duration, Number of Drinks, Number of Sips, or Sip Duration.

		Cross Elasticity Esimate Calculated* with:			
Subject	Phase Comparison	Drink Area Duration	Number of Drinks	Number of Sips	Sip Duration
6	1-2	0.00	0.00	0.00	0.00
	1-3	0.00	0.00	0.00	0.00
	1-4	0.00	0.00	0.00	0.00
	2-3	0.00	0.00	0.00	0.00
	3-4	0.00	0.00	0.00	0.00
	2-4	0.00	0.00	0.00	0.00
11	1-2	0.00	0.00	0.00	0.00
	1-3	0.00	0.00	0.00	0.00
	1-4	0.00	0.00	0.00	0.00
	2-3	+.82	+.66	+.06	-.08
	3-4	-.75	+.36	+1.24	+1.21
	2-4	+.12	+.50	+.46	+.34
14	1-2	+.27	+.16	+.38	+.28
	1-3	0.00	0.00	0.00	0.00
	1-4	+.14	-.03	+.18	+.08
	2-3	0.00	0.00	0.00	0.00
	3-4	0.00	0.00	0.00	0.00
	2-4	+.18	-.39	+.18	+.01
16	1-2	-1.83	-1.00	-.83	-.94
	1-3	0.00	0.00	0.00	0.00
	1-4	-.32	-.07	-.02	-.06
	2-3	0.00	0.00	0.00	0.00
	3-4	0.00	0.00	0.00	0.00
	2-4	+.25	+.60	+.72	+.58
18	1-2	-.62	-.04	-.05	-.10
	1-3	-.35	-.04	+.02	-.03
	1-4	+.04	+.29	+.38	+.26
	2-3	-.12	-.12	+.34	+.07
	3-4	+2.50	+3.33	+3.00	+2.89
	2-4	+.96	+1.28	+1.69	+1.33
19	1-2	0.00	0.00	0.00	0.00
	1-3	0.00	0.00	0.00	0.00
	1-4	0.00	0.00	0.00	0.00
	2-3	0.00	0.00	0.00	0.00
	3-4	0.00	0.00	0.00	0.00
	2-4	0.00	0.00	0.00	0.00

*All calculations utilize data obtained during stable responding.

Table 3-7. Cross Elasticity Estimates Comparing the Price of Game Playing with Alcohol Consumed or Blood Alcohol Level.

Subject	Phase Comparison	Cross Elasticity Estimate Calculated* with: Alcohol Consumed	Blood Alcohol Level
6	1-2	0.00	0.00
	1-3	0.00	0.00
	1-4	0.00	0.00
	2-3	0.00	0.00
	3-4	0.00	0.00
	2-4	0.00	0.00
11	1-2	0.00	0.00
	1-3	0.00	0.00
	1-4	0.00	0.00
	2-3	+.76	+.32
	3-4	+.24	+1.51
	2-4	+.50	+.75
14	1-2	+.16	0.00
	1-3	0.00	0.00
	1-4	-.03	0.00
	2-3	0.00	0.00
	3-4	0.00	0.00
	2-4	-.39	0.00
16	1-2	+1.00	0.00
	1-3	0.00	0.00
	1-4	-.07	0.00
	2-3	0.00	0.00
	3-4	0.00	0.00
	2-4	-.60	+.48
18	1-2	-.04	+.06
	1-3	-.04	-.13
	1-4	+.29	+.88
	2-3	-.12	-1.13
	3-4	+3.33	-13.00
	2-4	+1.28	+3.00
19	1-2	0.00	0.00
	1-3	0.00	0.00
	1-4	0.00	0.00
	2-3	0.00	0.00
	3-4	0.00	0.00
	2-4	0.00	0.00

*All calculations utilize data obtained during stable responding.

Table 3-8. Cross Elasticity Estimates Comparing the Price of Game Playing with Three Measures of "Other Behavior."

Subject	Phase Comparison	Cross Elasticity Estimated Calculated* with: 3600-drink area dur. + game area dur.	3600-sip dur.+ game area dur.	stereotypic behavior
6	1-2	-12.66	-12.71	0.00
	1-3	-7.42	-7.42	0.00
	1-4	-3.69	-3.69	0.00
	2-3	-.24	-.24	+8.10
	3-4	-.11	-.11	-4.04
	2-4	-.12	-.12	+.11
11	1-2	-2.46	-7.24	-522.25
	1-3	-5.08	-11.78	-1300.00
	1-4	-3.12	-20.14	-3784.00
	2-3	-.04	+.42	-.48
	3-4	+4.15	+.45	-1.36
	2-4	+1.30	+.39	-.81
14	1-2	-3.36	-2.35	-6.02
	1-3	-2.05	-1.40	+1.01
	1-4	-1.30	-.91	-1.70
	2-3	-.28	-.24	+2.39
	3-4	-.16	-.20	-2.58
	2-4	-.18	-.18	0.00
16	1-2	-2.92	-2.65	-87.40
	1-3	-2.00	-1.37	-58.49
	1-4	-1.09	-.89	-29.94
	2-3	-.46	-.04	-.50
	3-4	+.06	-.18	+.18
	2-4	-.15	-.08	-.11
18	1-2	-.63	-.65	-.86
	1-3	-.39	-.39	-.69
	1-4	-.38	-.18	-.06
	2-3	-.19	-.15	-.59
	3-4	-.74	-.05	+1.35
	2-4	-.42	-.06	+.60
19	1-2	-7.14	-5.74	0.00
	1-3	-4.14	-3.33	0.00
	1-4	-2.14	-1.72	0.00
	2-3	-.21	-.21	-1.66
	3-4	-.15	-.15	-.25
	2-4	-.13	-.13	-.69

*All calculations utilize data obtained during stable responding.

Table 3-9. Elasticity Estimates Comparing the Price of Game Playing with Game Playing Units or Number of Games Played.

Subject	Phase Comparison	Elasticity Estimate*	Elasticity Estimate**
6	1-2	-1.16	-1.92
	1-3	-1.00	-1.18
	1-4	-1.00	-1.02
	2-3	-.75	-.27
	3-4	-1.00	-.77
	2-4	-.85	=.47
11	1-2	-2.00	-1.36
	1-3	-4.00	-1.95
	1-4	-1.33	-.08
	2-3	-2.62	-.52
	3-4	-.90	-6.30
	2-4	-1.17	-2.89
14	1-2	-.94	-1.68
	1-3	-.82	-1.35
	1-4	-1.10	-1.57
	2-3	-.75	-.69
	3-4	-1.32	-1.45
	2-4	-1.66	-1.05
16	1-2	-1.67	-1.30
	1-3	-.83	-1.05
	1-4	-1.09	-.69
	2-3	0.00	-.66
	3-4	-1.66	-.20
	2-4	-.60	-.37
18	1-2	-1.08	-1.41
	1-3	-1.33	-1.00
	1-4	-.94	-1.16
	2-3	-1.50	-.45
	3-4	-1.50	-1.30
	2-4	-.85	-1.28
19	1-2	-1.11	-.61
	1-3	-.96	-1.05
	1-4	-.96	-1.53
	2-3	-.75	-2.04
	3-4	-1.00	-1.83
	2-4	-.86	-2.42

*Calculated with total units purchased of game playing during stable responding.

**Calculated with total number of games played during stable responding.

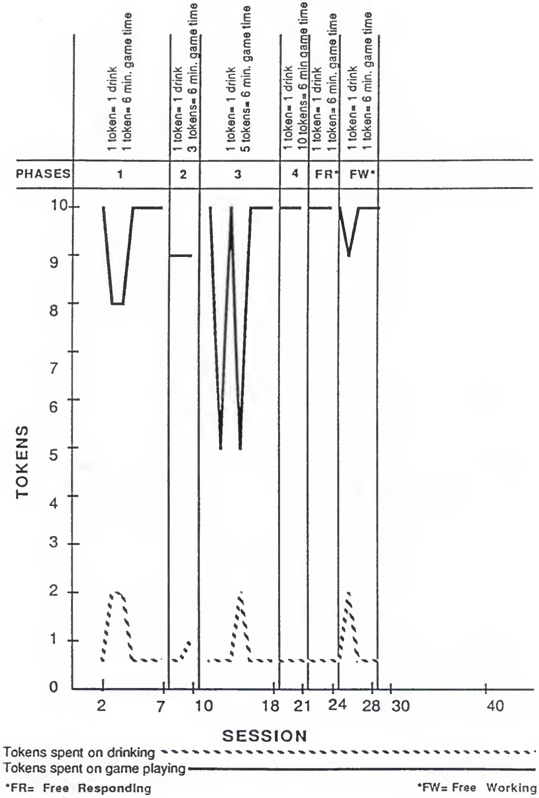


Figure 3-1. Subject 6--Token Expenditures on Drinking and Game Playing per Session.

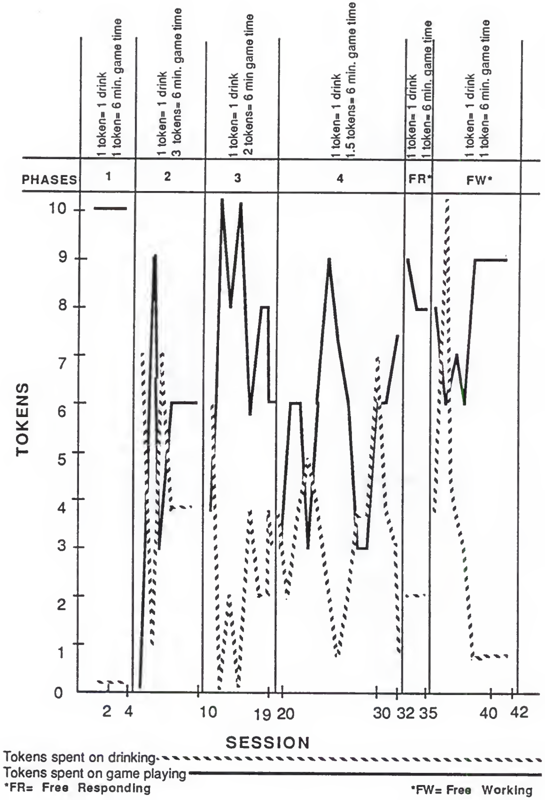


Figure 3-2. Subject 11--Token Expenditures on Drinking and Game Playing per Session.

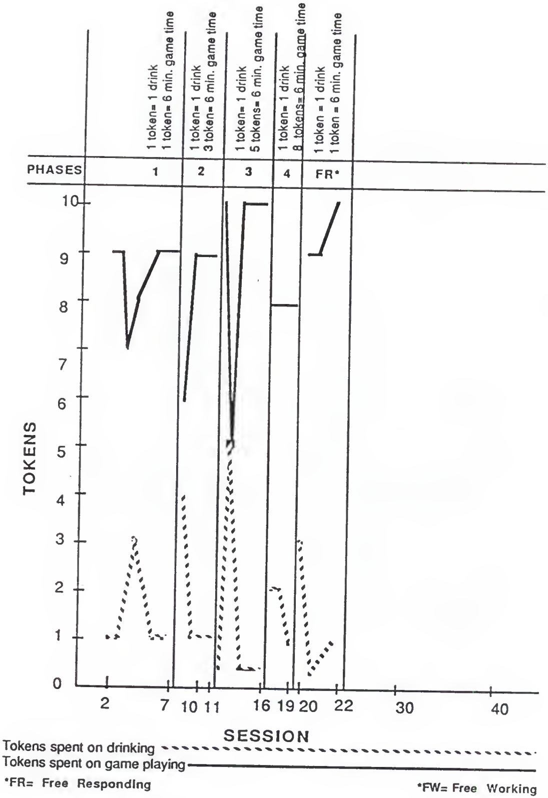


Figure 3-3. Subject 14--Token Expenditures on Drinking and Game Playing per Session.

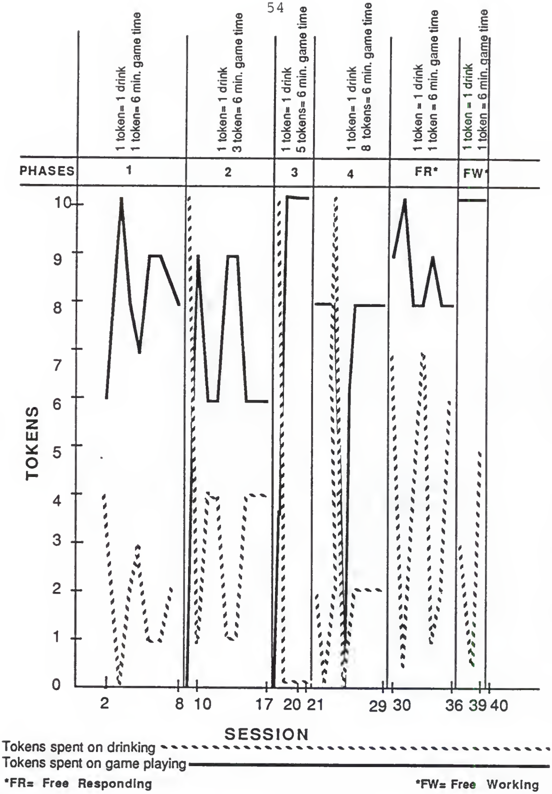


Figure 3-4. Subject 16--Token Expenditures on Drinking and Game Playing per Session.

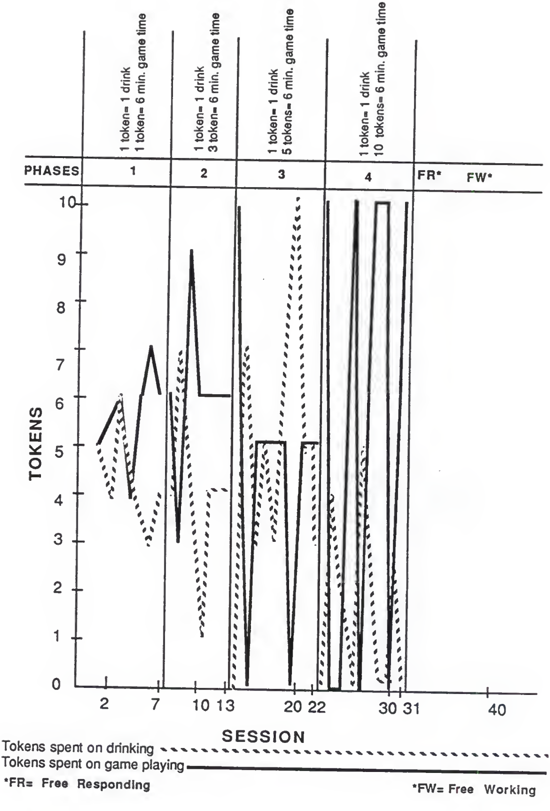


Figure 3-5. Subject 18--Token Expenditures on Drinking and Game Playing per Session.

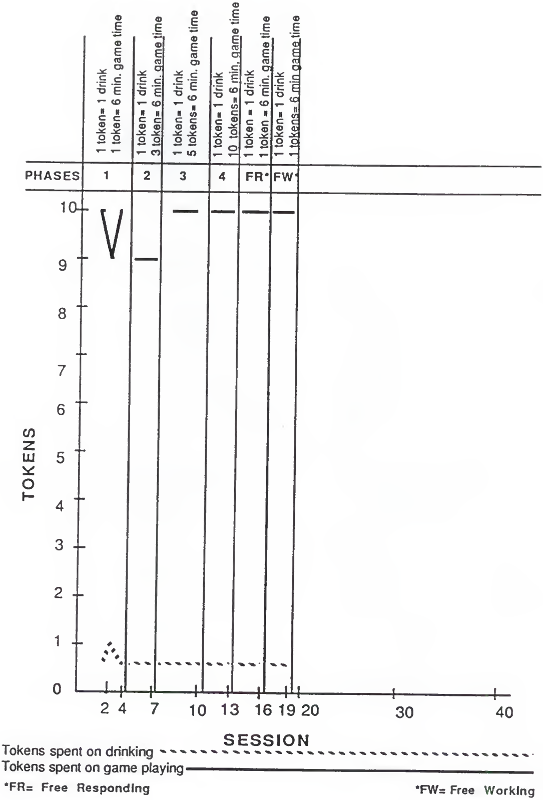


Figure 3-6. Subject 19--Token Expenditures on Drinking and Game Playing per Session.

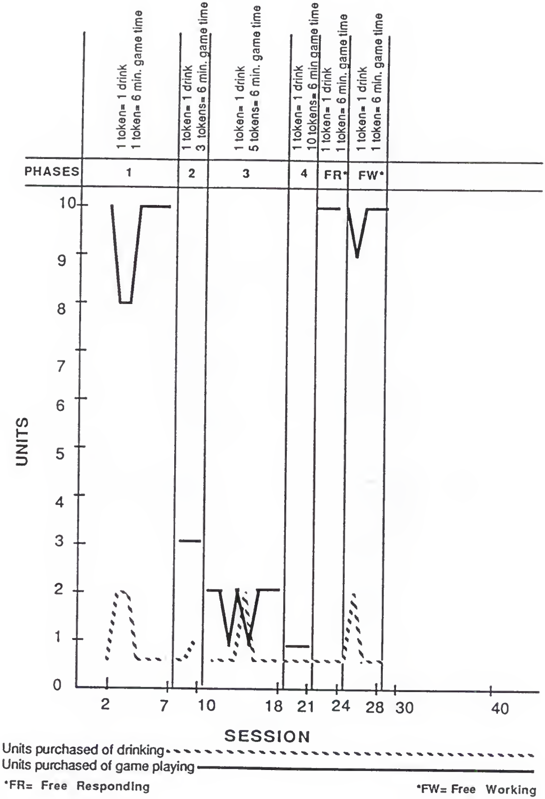


Figure 3-7. Subject 6--Units Purchased of Drinking and Game Playing per Session.

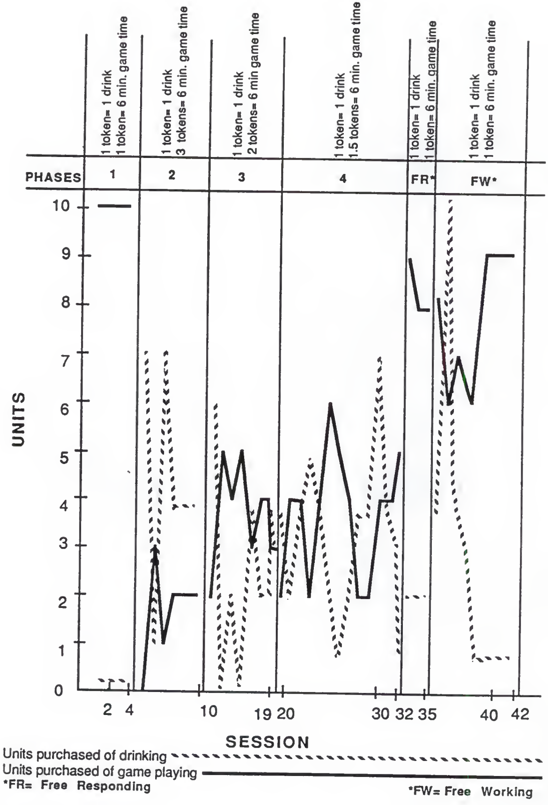


Figure 3-8. Subject 11--Units Purchased of Drinking and Game Playing per Session.

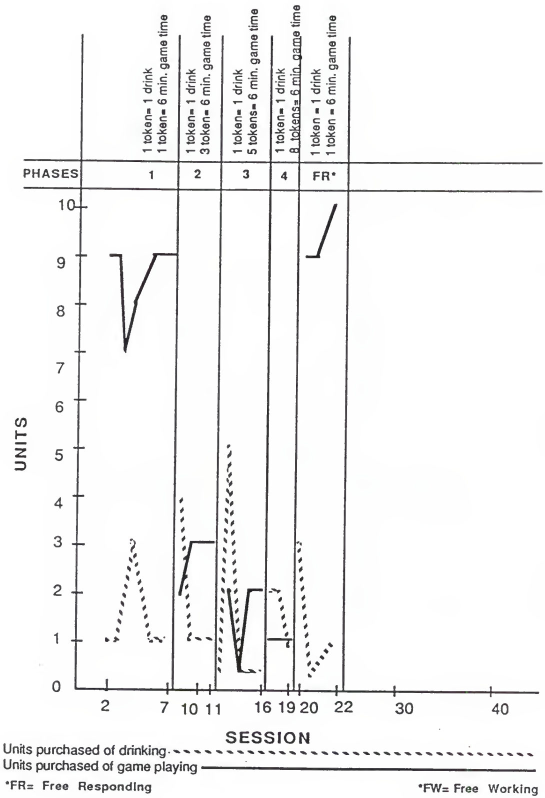


Figure 3-9. Subject 14--Units Purchased of Drinking and Game Playing per Session.

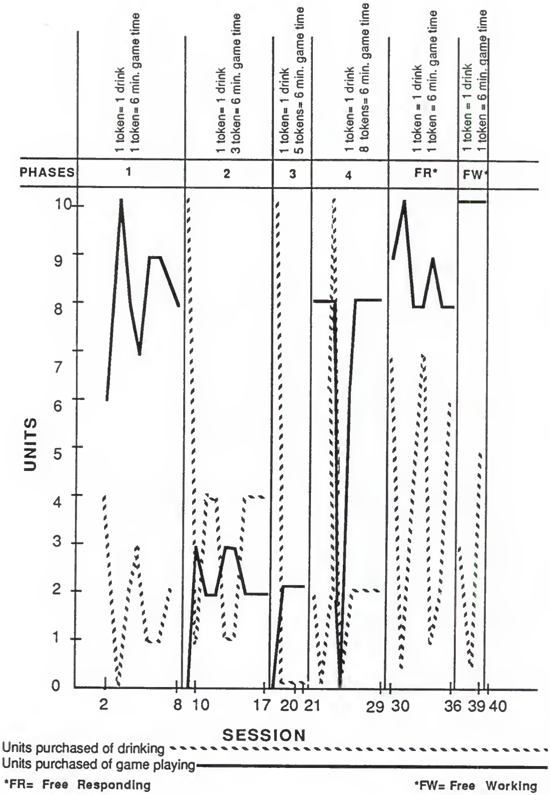


Figure 3-10. Subject 16--Units Purchased of Drinking and Game Playing per Session.

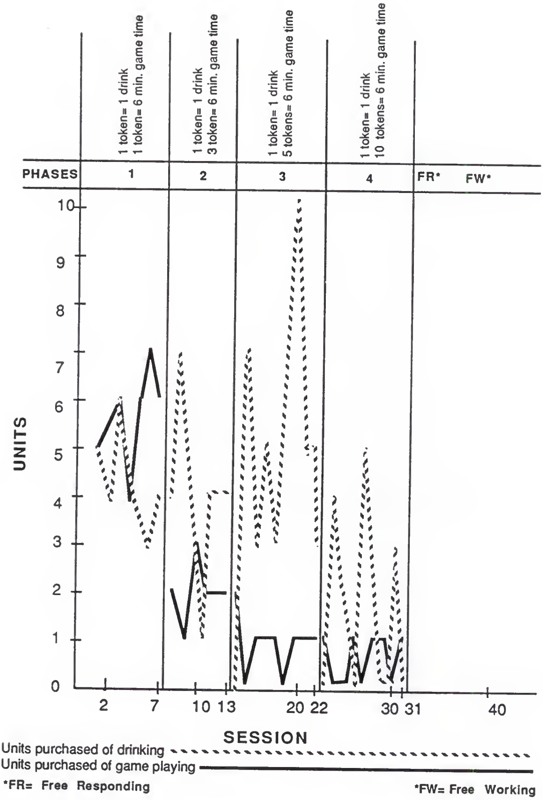


Figure 3-11. Subject 18--Units Purchased of Drinking and Game Playing per Session.

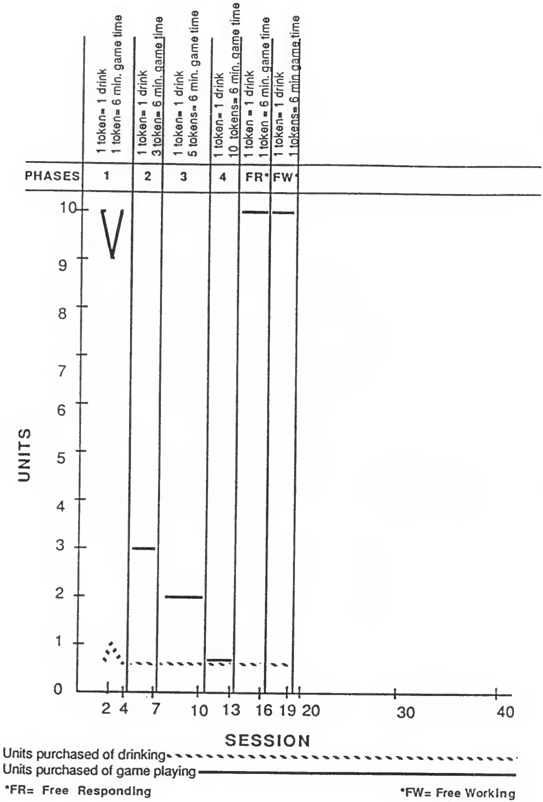


Figure 3-12. Subject 19--Units Purchased of Drinking and Game Playing per Session.

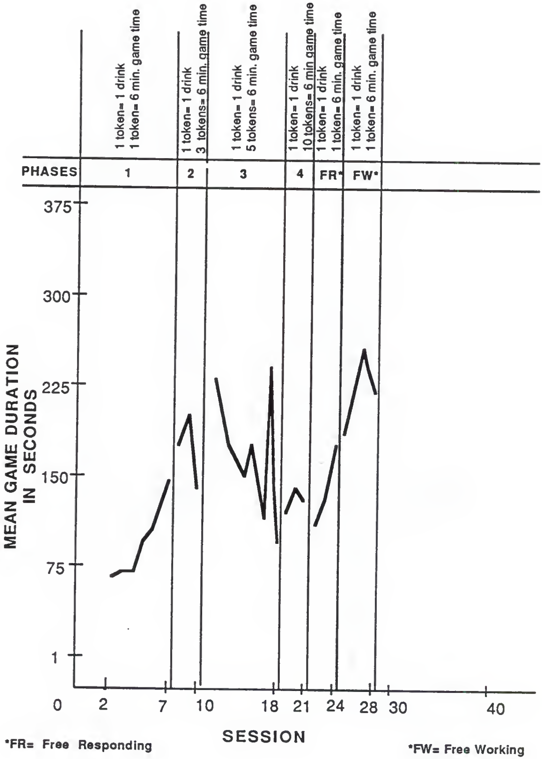


Figure 3-13. Subject 6--Mean Game Duration per Session.

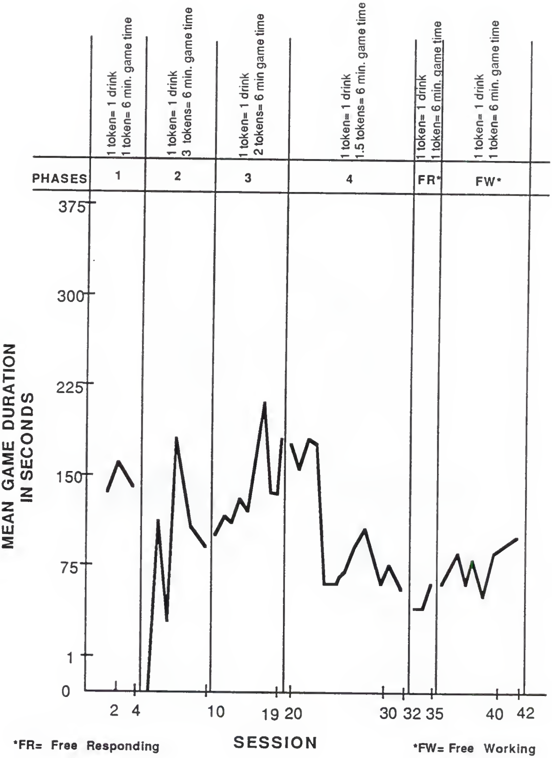


Figure 3-14. Subject 11--Mean Game Duration per Session.

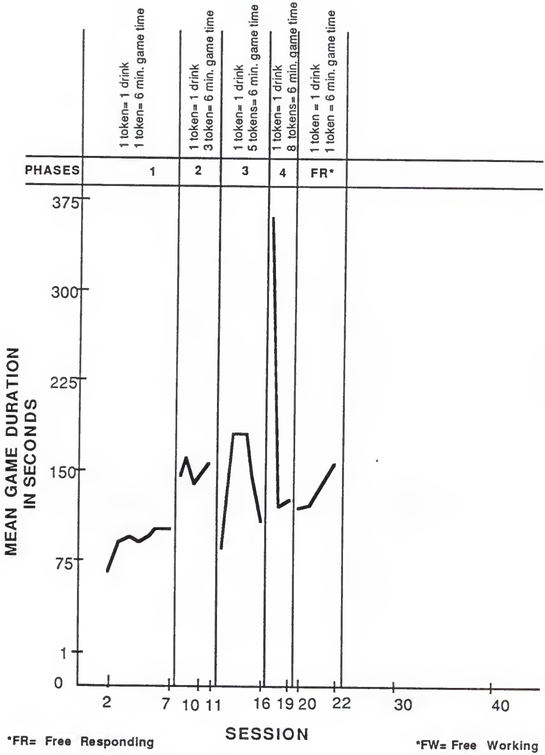


Figure 3-15. Subject 14--Mean Game Duration per Session.

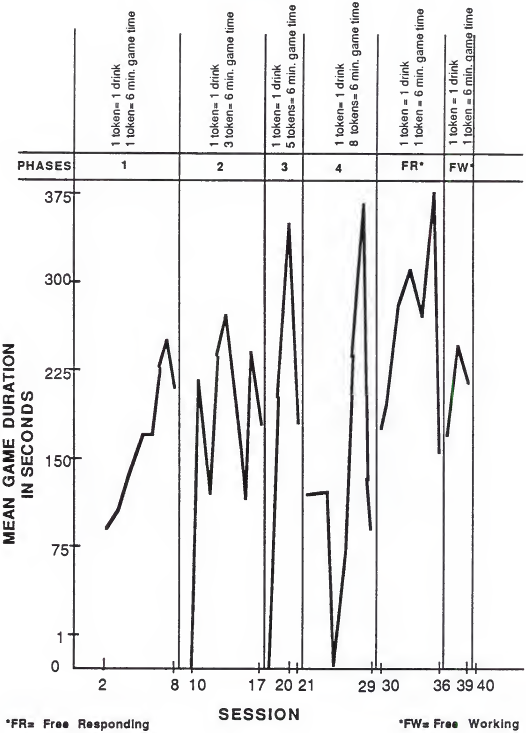


Figure 3-16. Subject 16--Mean Game Duration per Session.

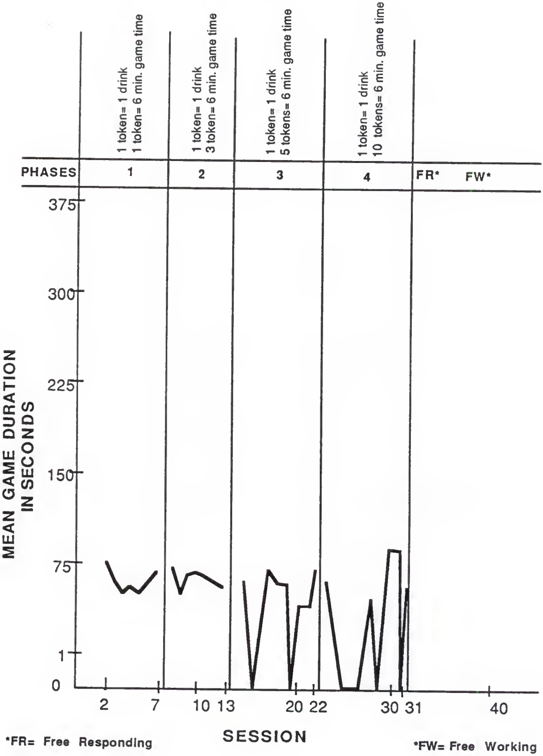


Figure 3-17. Subject 18--Mean Game Duration per Session.

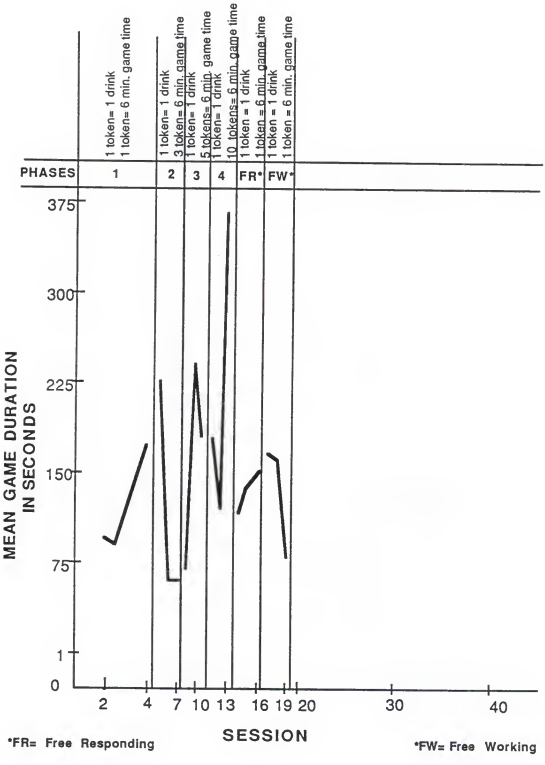


Figure 3-18. Subject 19--Mean Game Duration per Session.

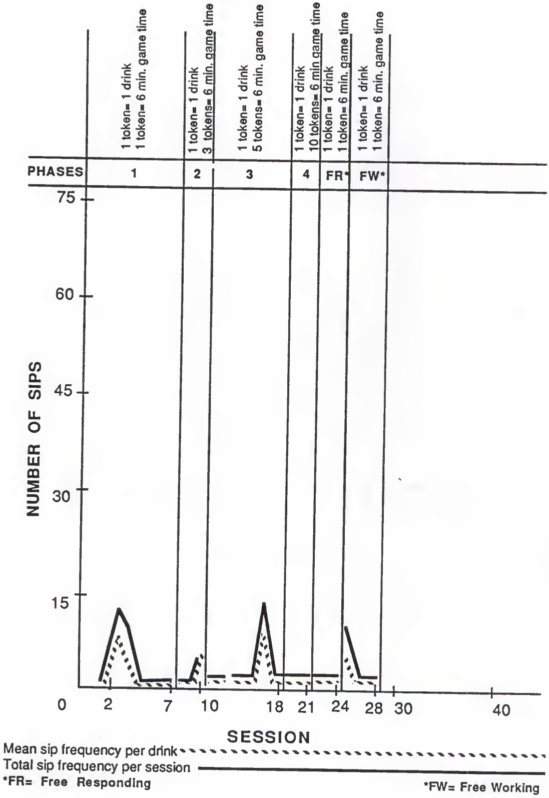


Figure 3-19. Subject 6--Mean Sip Frequency per Drink and Total Sip Frequency per Session.

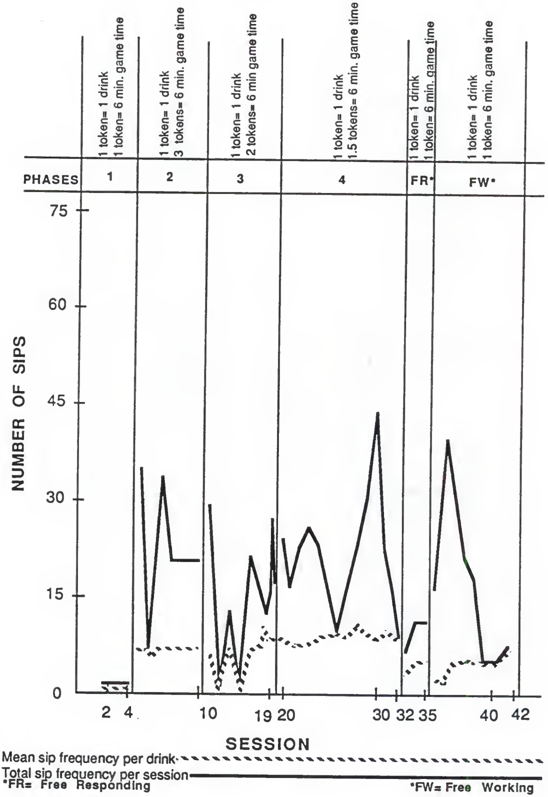


Figure 3-20. Subject 11--Mean Sip Frequency per Drink and Total Sip Frequency per Session.

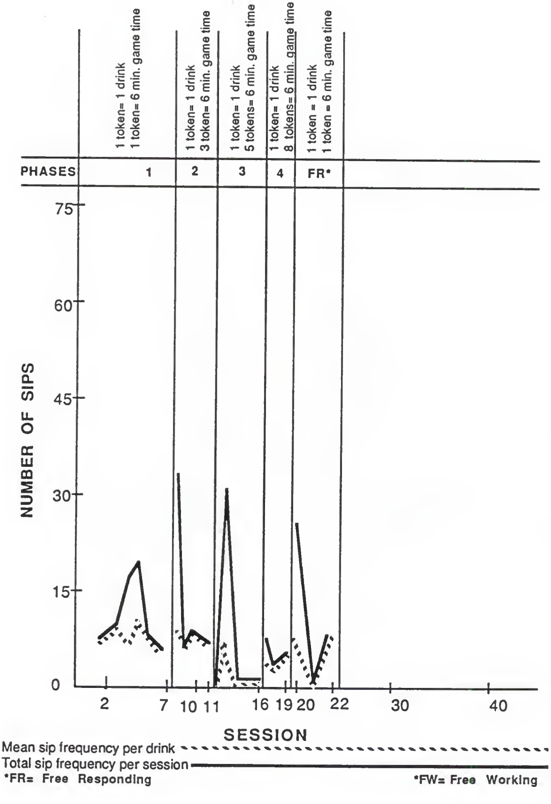


Figure 3-21. Subject 14--Mean Sip Frequency per Drink and Total Sip Frequency per Session.

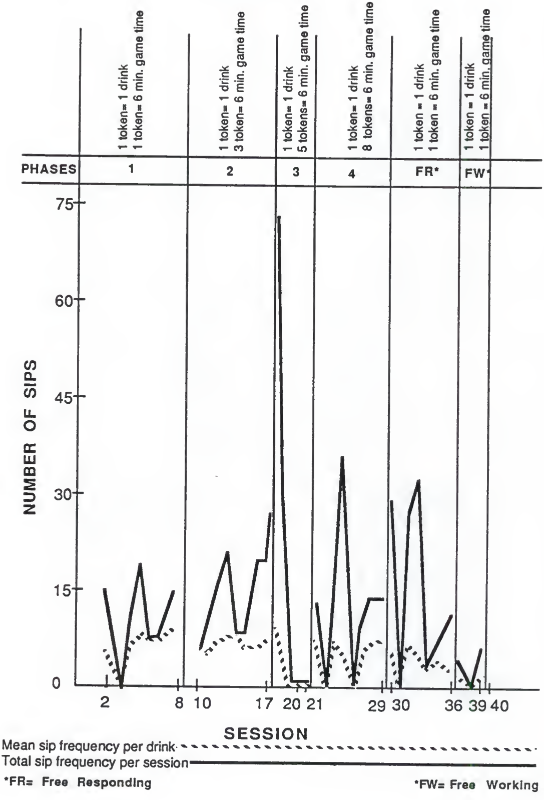


Figure 3-22. Subject 16--Mean Sip Frequency per Drink and Total Sip Frequency per Session.

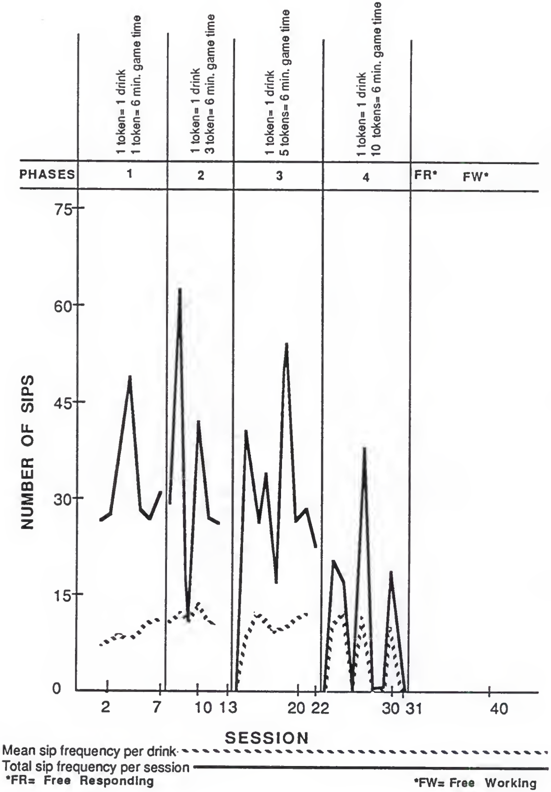


Figure 3-23. Subject 18--Mean Sip Frequency per Drink and Total Sip Frequency per Session.

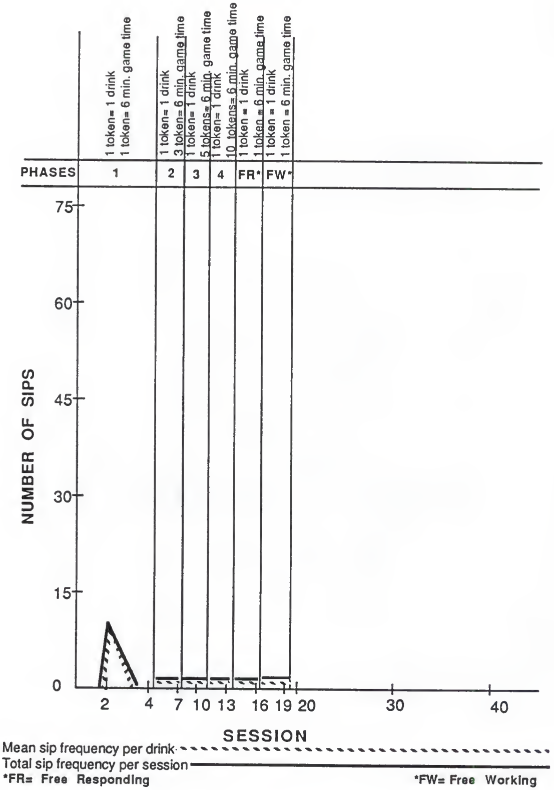


Figure 3-24. Subject 19--Mean Sip Frequency per Drink and Total Sip Frequency per Session.

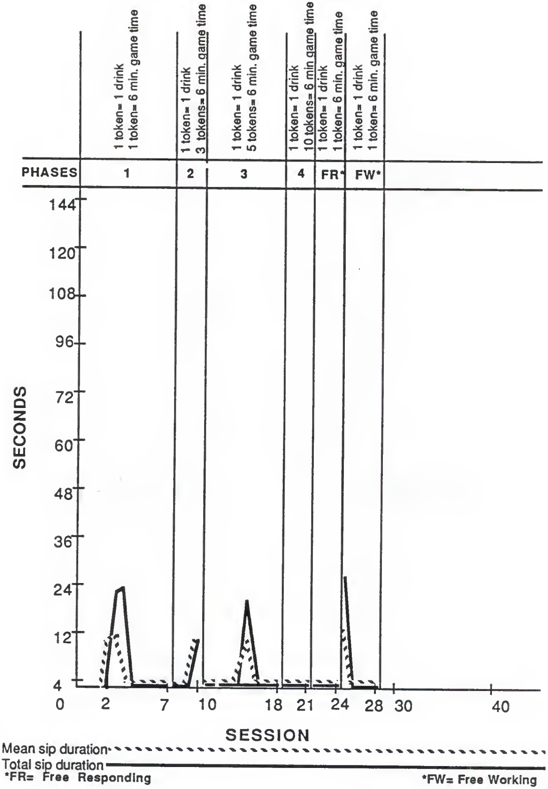


Figure 3-25. Subject 6--Mean Sip Duration per Drink and Total Sip Duration per Session.

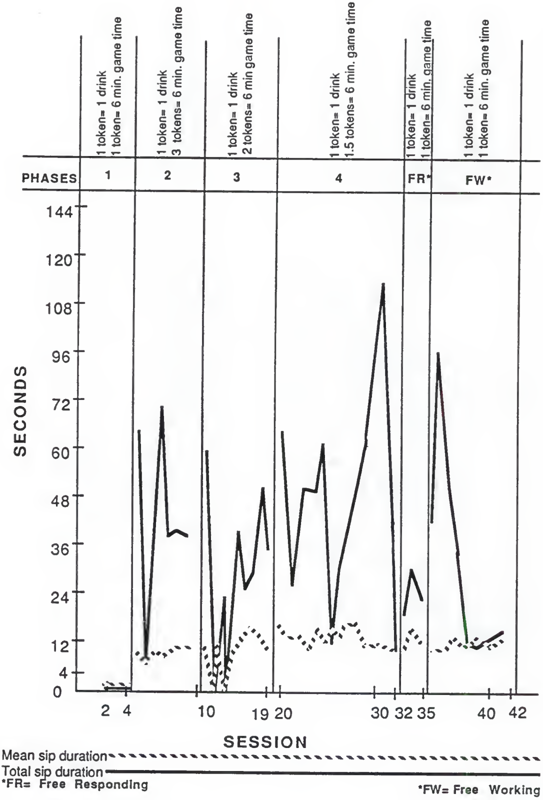


Figure 3-26. Subject 11--Mean Sip Duration per Drink and Total Sip Duration per Session.

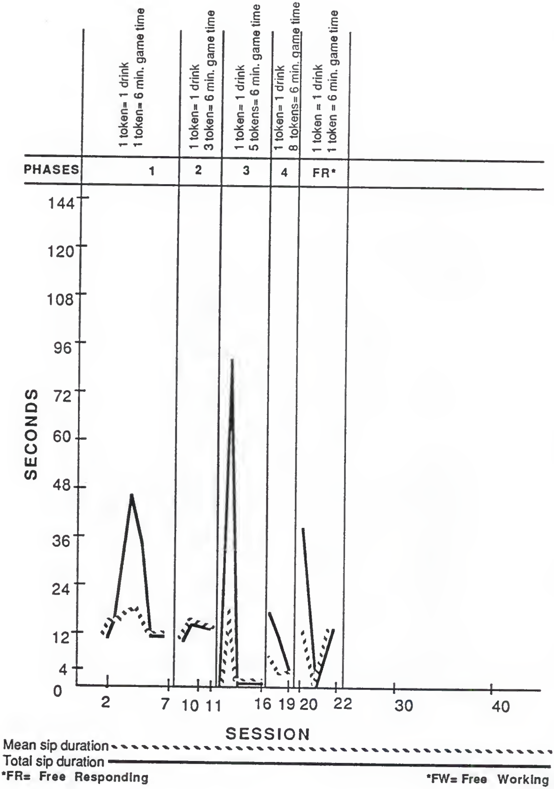


Figure 3-27. Subject 14--Mean Sip Duration per Drink and Total Sip Duration per Session.

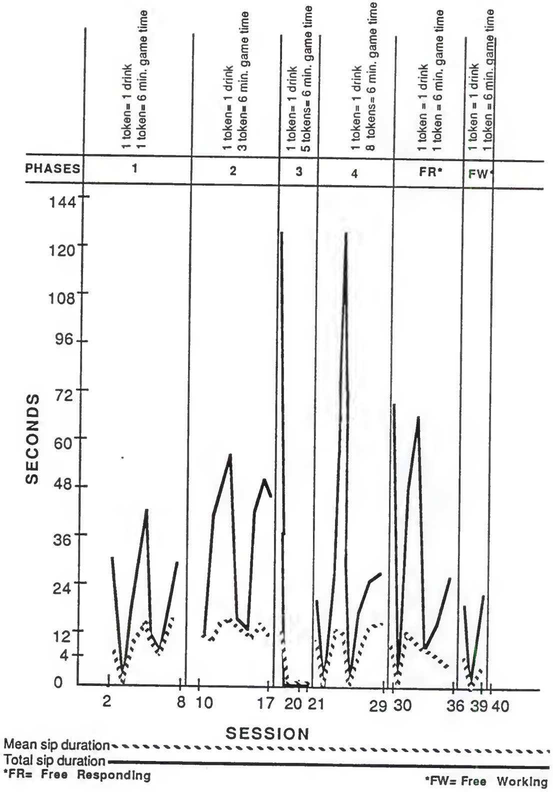


Figure 3-28. Subject 16--Mean Sip Duration per Drink and Total Sip Duration per Session.

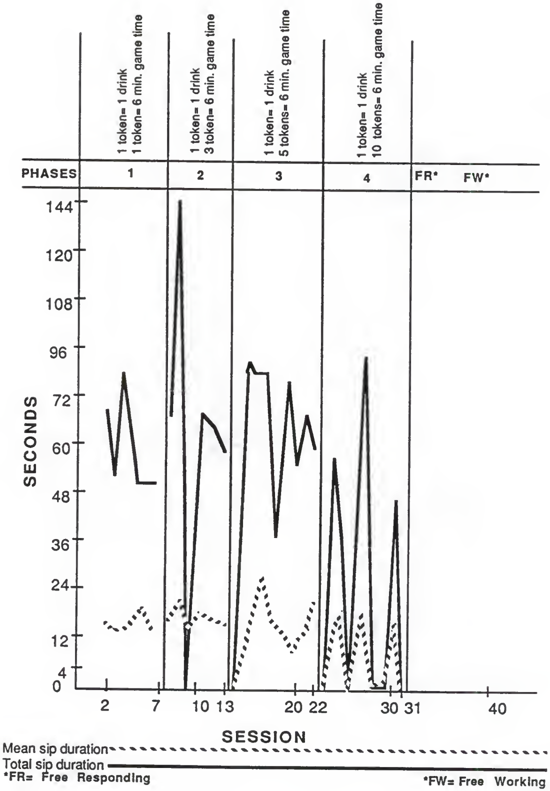


Figure 3-29. Subject 18--Mean Sip Duration per Drink and Total Sip Duration per Session.

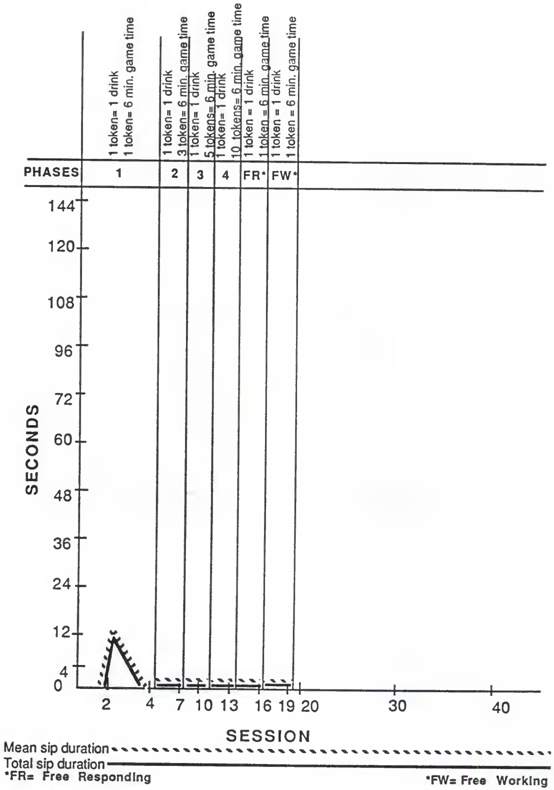
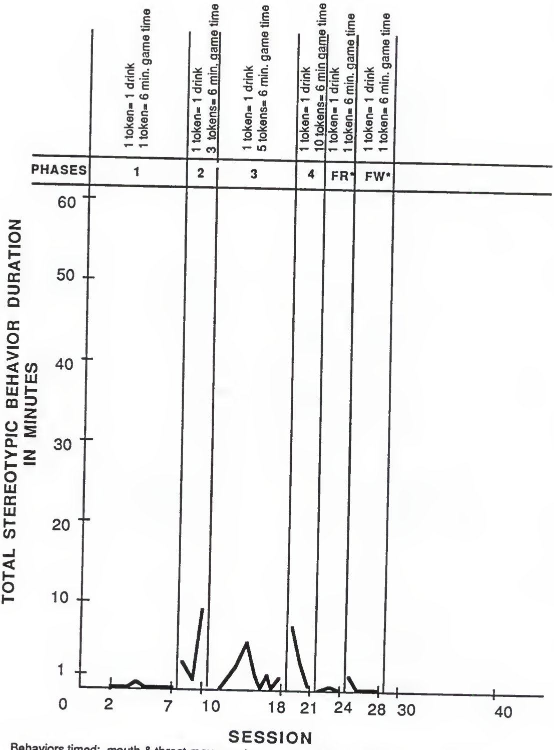


Figure 3-30. Subject 19--Mean Sip Duration per Drink and Total Sip Duration per Session.



Behaviors timed: mouth & throat movements
finger tapping
scratching

plays with joystick
plays with tokens
settles in chair

head jerks

*FR= Free Responding

*FW= Free Working

Figure 3-31. Subject 6--Stereotypic Behavior Duration per Session.

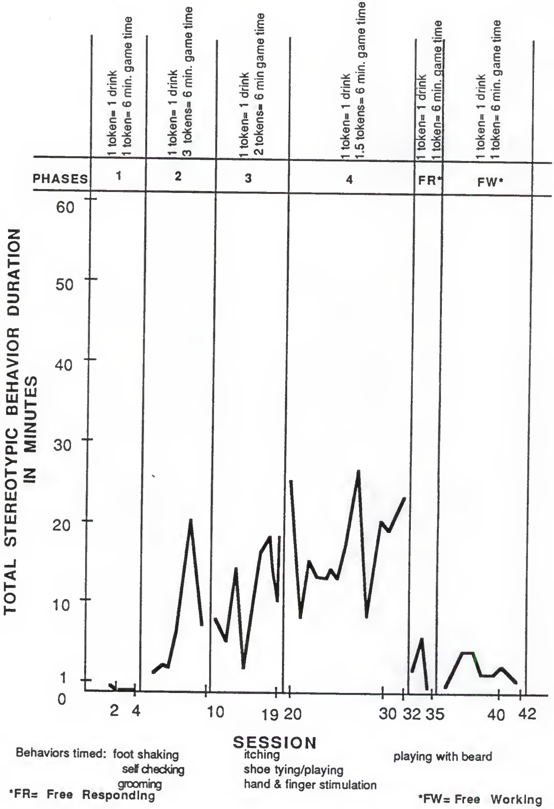
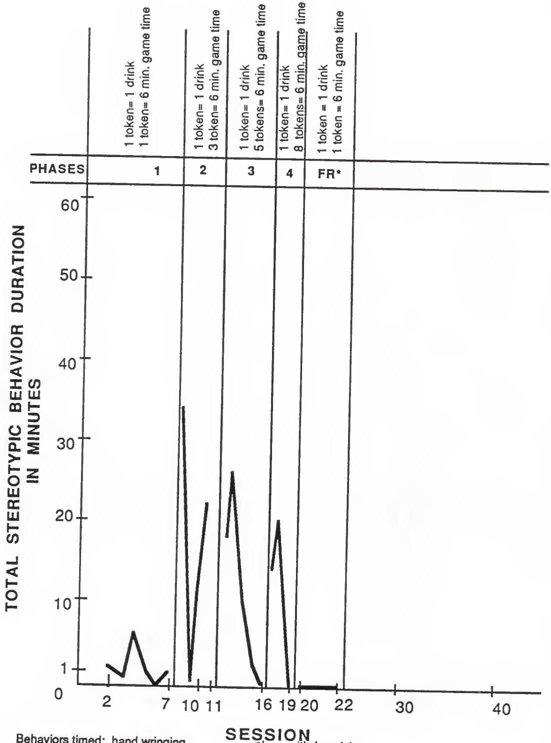


Figure 3-32. Subject 11--Stereotypic Behavior Duration per Session.

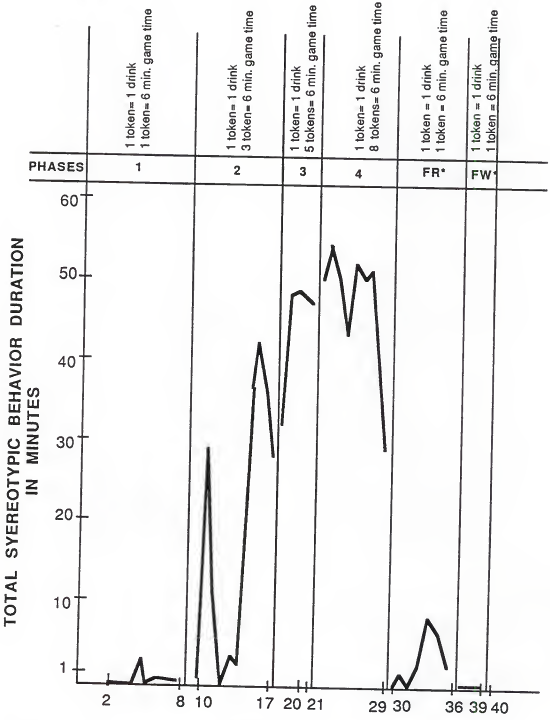


Behaviors timed: hand wringing
foot tapping
wallet examining
plays with joystick
paper folding
jaw & leg movement

*FR= Free Responding

*FW= Free Working

Figure 3-33. Subject 14--Stereotypic Behavior Duration per Session.



Behaviors timed: foot/hand tapping
toe/leg/foot wiggling
plays with tokens
mouth movements

*FR= Free Responding

*FW= Free Working

Figure 3-34. Subject 16--Stereotypic Behavior Duration per Session.

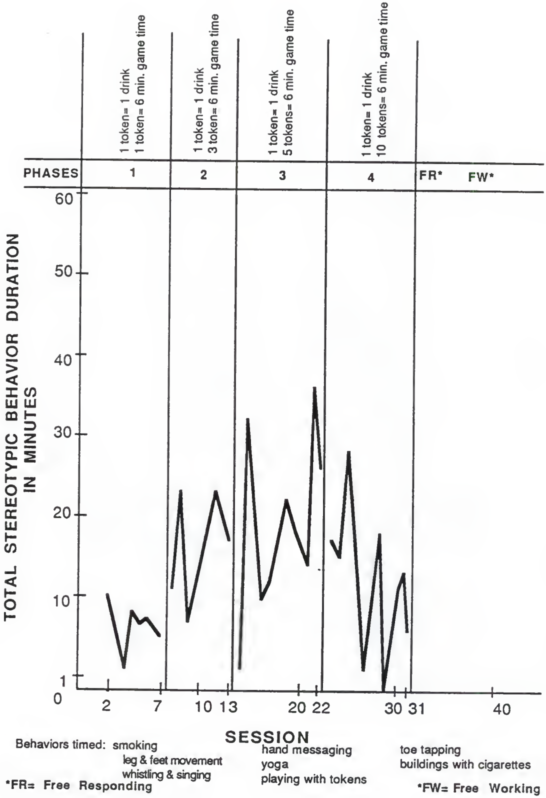
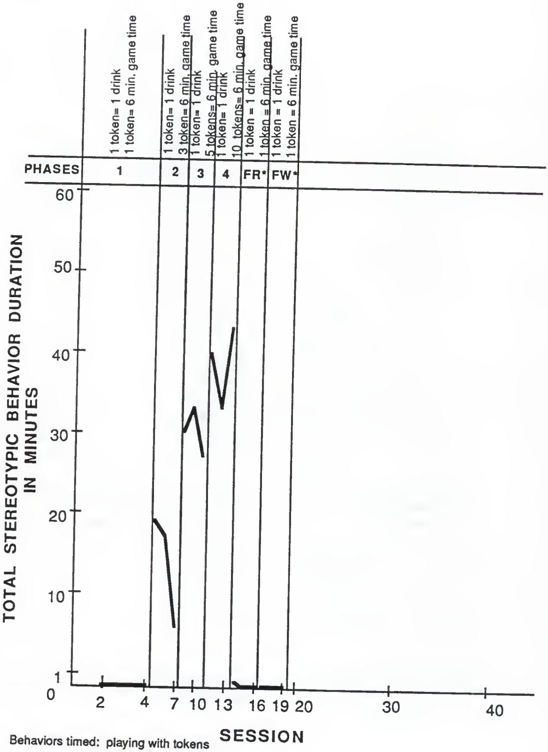


Figure 3-35. Subject 18--Stereotypic Behavior Duration per Session.



Behaviors timed: playing with tokens
finger & foot tapping
"dominoes" with tokens

*FR= Free Responding

*FW= Free Working

Figure 3-36. Subject 19--Stereotypic Behavior Duration per Session.

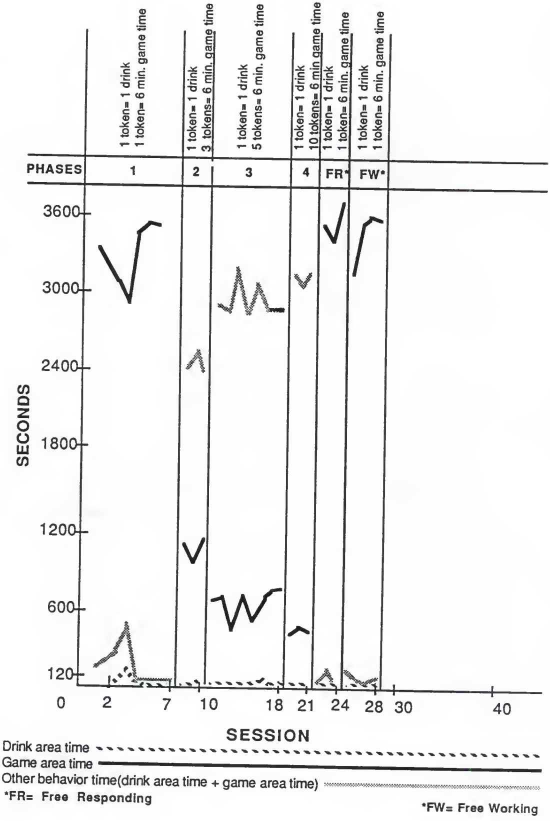


Figure 3-37. Subject 6--Drink Area, Game Area, and Other Duration per Session.

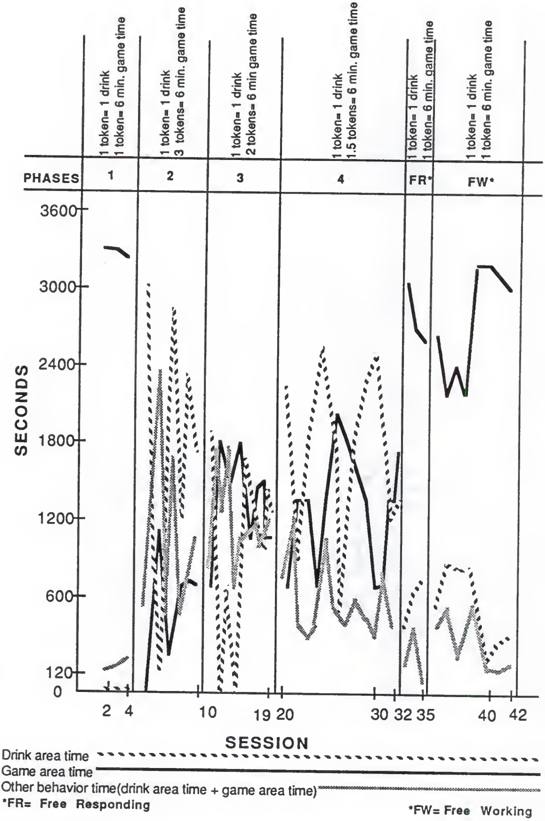


Figure 3-38. Subject 11--Drink Area, Game Area, and Other Duration per Session.

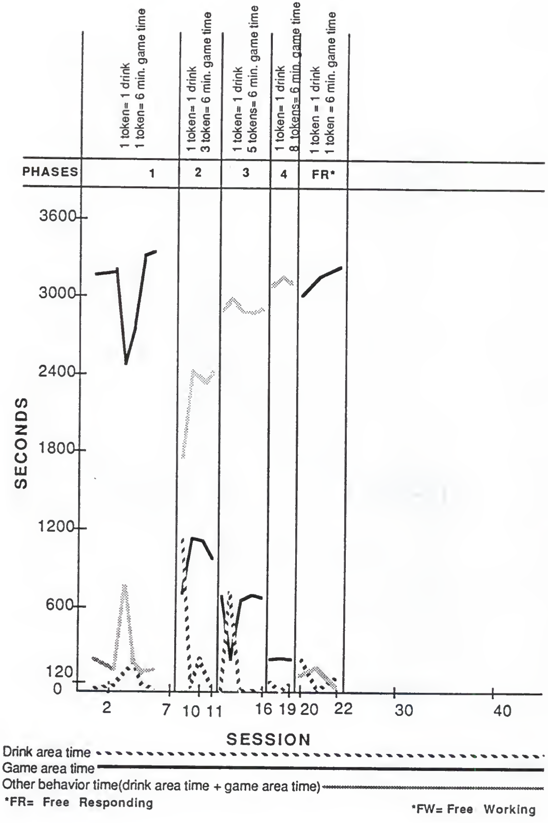


Figure 3-39. Subject 14--Drink Area, Game Area, and Other Duration per Session.

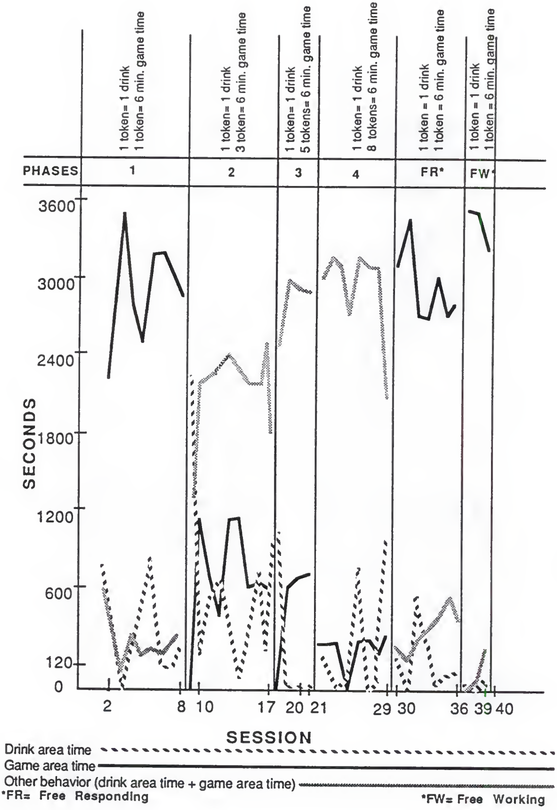


Figure 3-40. Subject 16--Drink Area, Game Area, and Other Duration per Session.

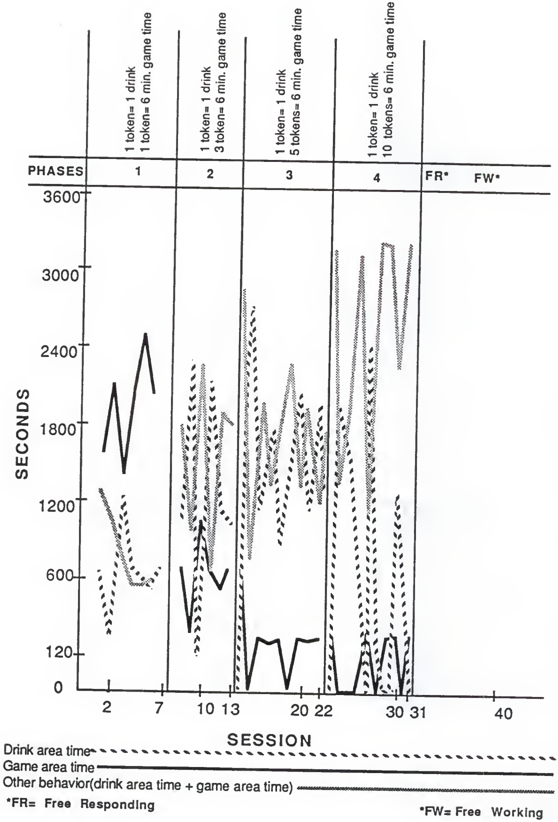


Figure 3-41. Subject 18--Drink Area, Game Area, and Other Duration per Session.

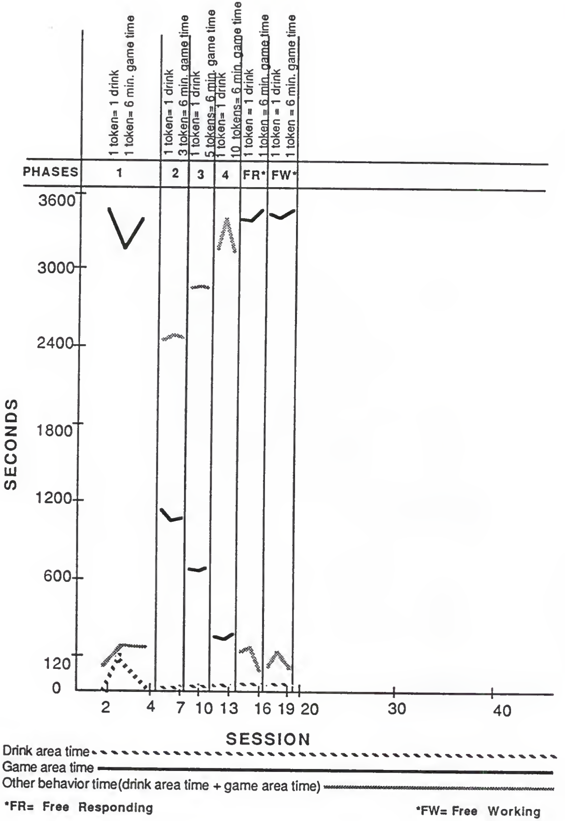


Figure 3-42. Subject 19--Drink Area, Game Area, and Other Duration per Session.

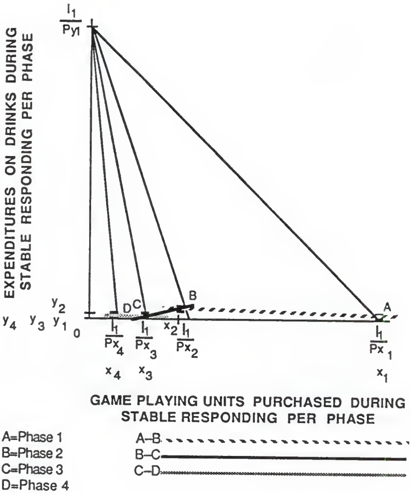


Figure 3-43. Subject 6--Price Consumption Curves.

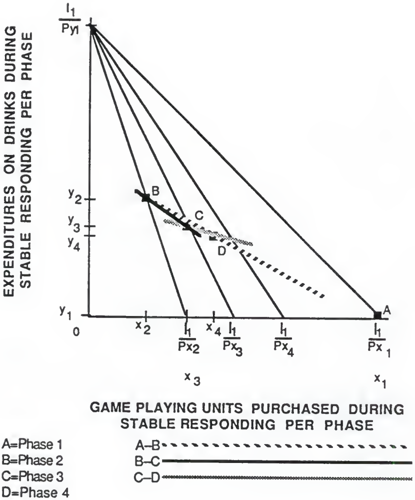


Figure 3-44. Subject 11--Price Consumption Curves.

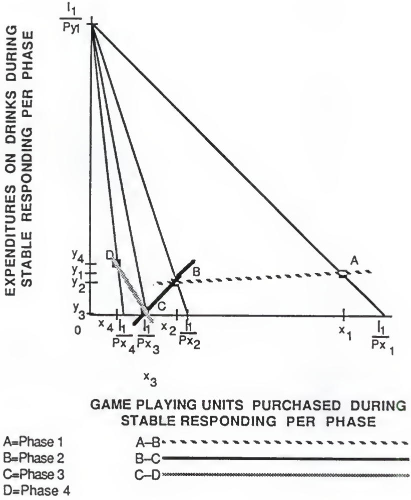


Figure 3-45. Subject 14--Price Consumption Curves.

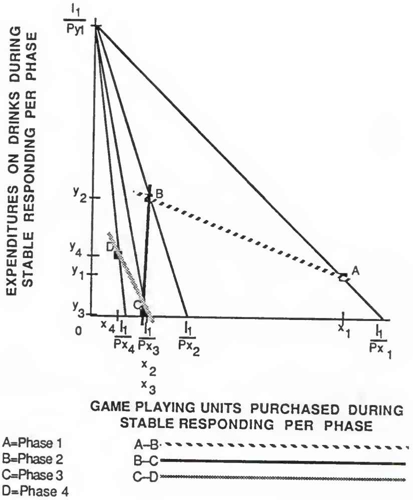


Figure 3-46. Subject 16--Price Consumption Curves.

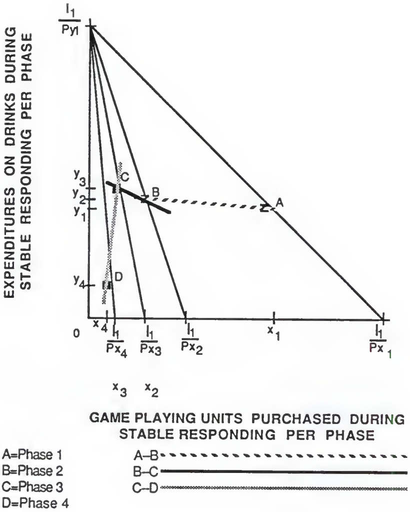


Figure 3-47. Subject 18--Price Consumption Curves.

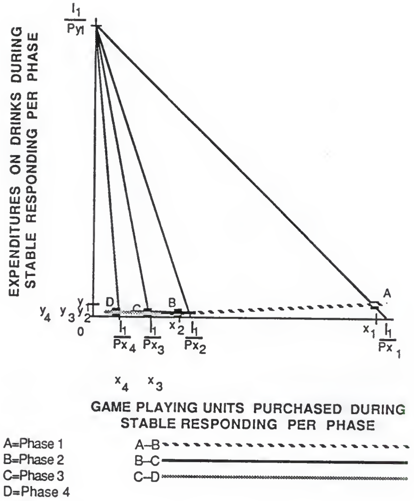


Figure 3-48. Subject 19--Price Consumption Curves.

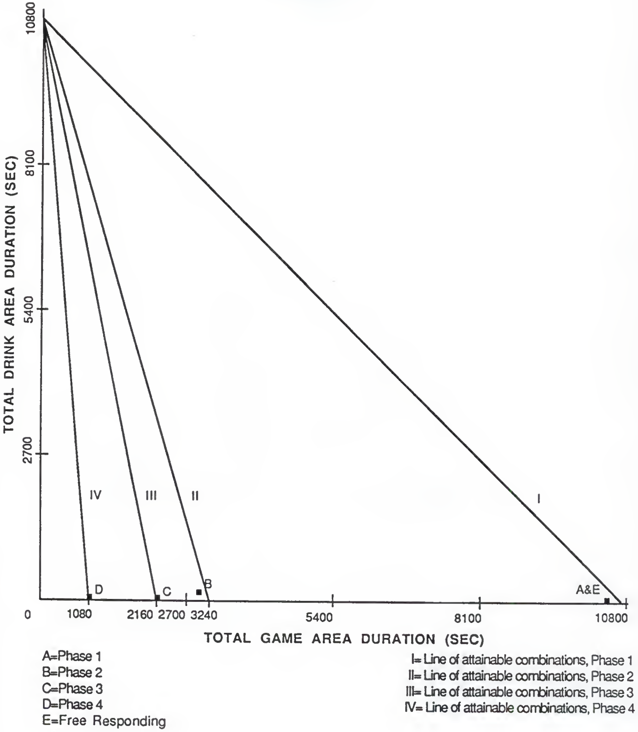


Figure 3-49. Subject 6--Preference Packages Chosen per Phase.

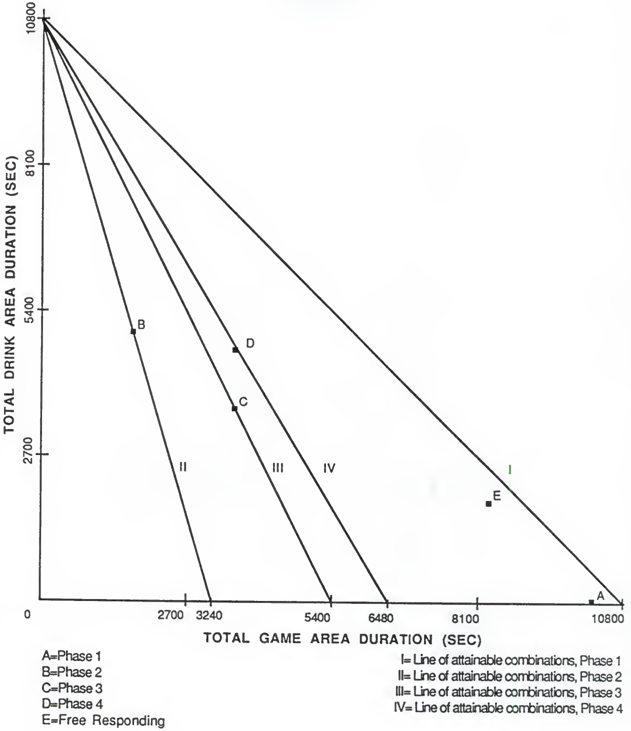


Figure 3-50. Subject 11--Preference Packages Chosen per Phase.

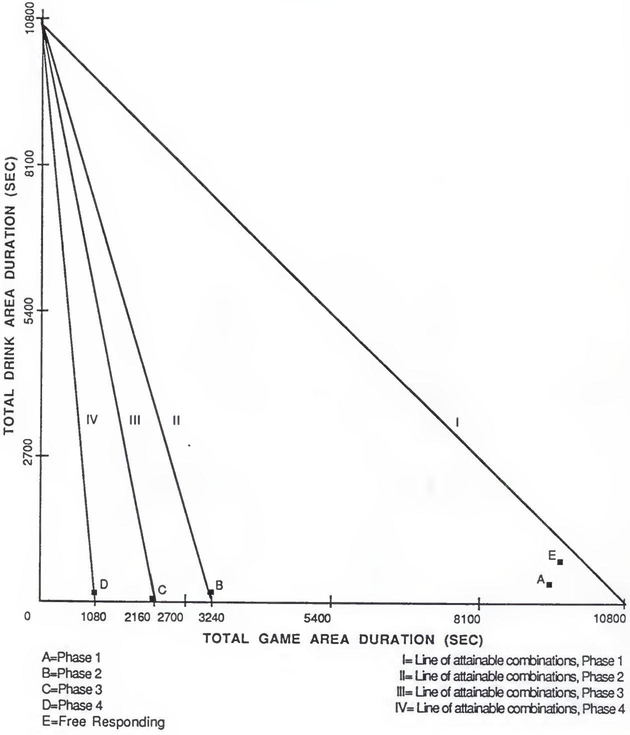


Figure 3-51. Subject 14--Preference Packages Chosen per Phase.

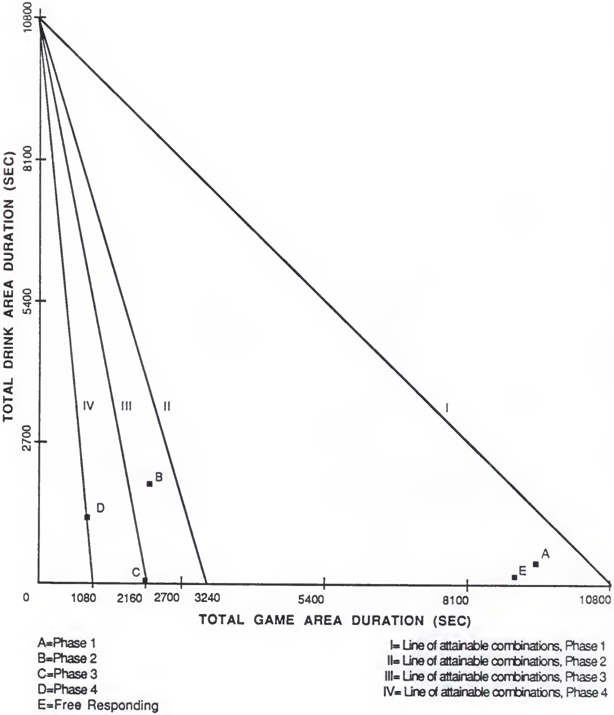


Figure 3-52. Subject 16--Preference Packages Chosen per Phase.

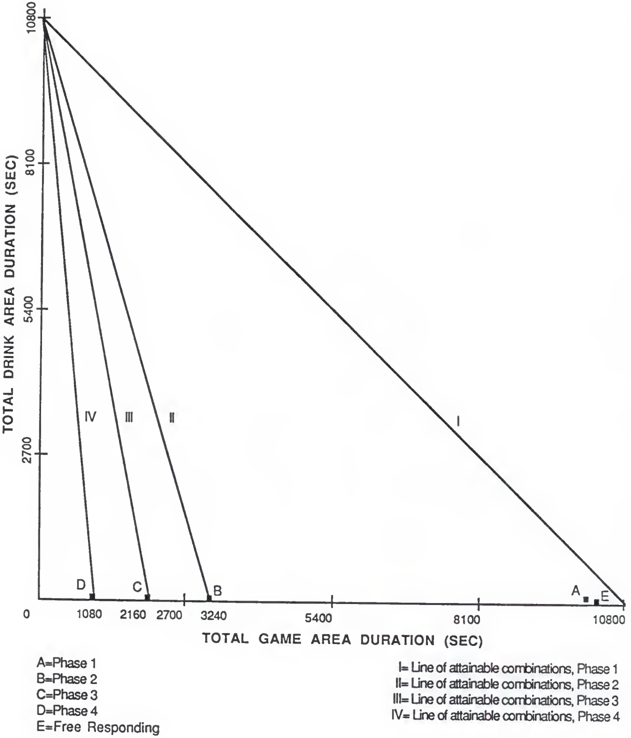


Figure 3-53. Subject 19--Preference Packages Chosen per Phase.

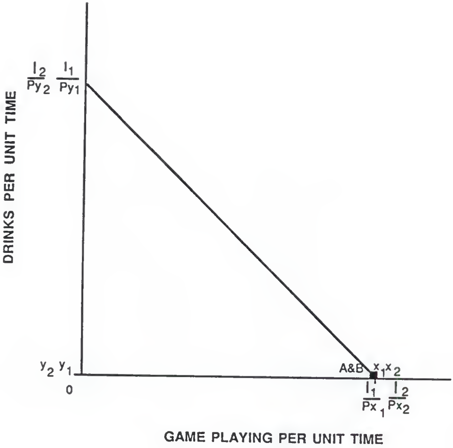


Figure 3-54. Subject 6--Income Consumption Curve.

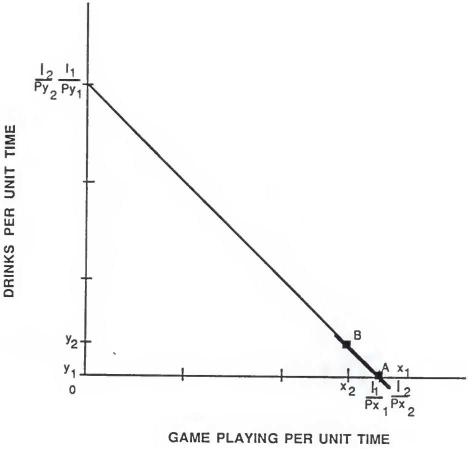


Figure 3-55. Subject 11--Income Consumption Curve.

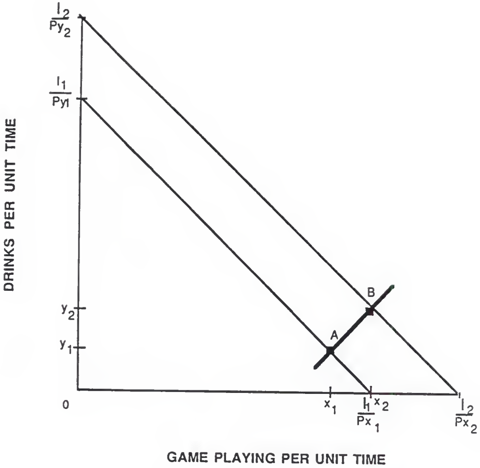


Figure 3-56. Subject 16--Income Consumption Curve.

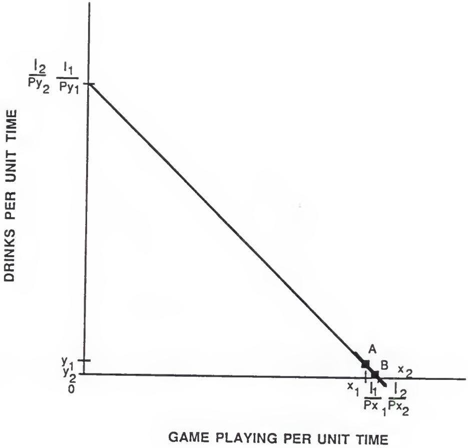


Figure 3-57. Subject 19--Income Consumption Curve.

Procedures and Reliability

Number of Sessions and Price of Game Playing

The procedures are summarized in Table 3-1. This table depicts the number of sessions subjects spent in each phase and the price they paid for game playing.

Inter-rater Reliability

Inter-rater reliability checks were obtained on 10% of sessions. The percent agreement of observation between the primary investigator and each of the three assistants is summarized in Table 3-2. Percent agreement was calculated for frequencies by dividing the smaller number of occurrences observed by the larger number and multiplying by 100 (Bailey & Bostow, 1979). For durations, percent agreement was calculated by dividing the smaller duration recorded by the larger duration and multiplying by 100 (Bailey & Bostow, 1979). The slightly higher values than those obtained in the Pilot reflect minor adjustments made in the angle of the raters´ views of subjects.

Questionnaires

Drinking Questionnaires

Subjects´ responses to questionnaires are summarized in Table 3-3. Classification categories on the Drinking

Practices Questionnaire have been further subdivided into Hi, Mid, and Lo to allow finer discrimination between subject responses. Although responding on this questionnaire generally varies with responding on the Alcohol Use Inventory, there appears to be a lack of specific predictive validity between the two instruments. Subjects 14, 16, and 18 score within one point of one another (18 or 19) on the Alcohol Use Inventory (AUI) and fall within the same category (Heavy-Lo) on the Drinking Practices Questionnaire (DPQ). Subjects 6 and 19, however, also score within one point of each other (8 or 7) on the AUI and fall within different categories (Moderate-Mid, Light-Mid) on the DPQ. Subject 11 attained a much higher score (25) on the AUI than any other subject, but failed to fall within a higher category on the DPQ. Instead, he attained a category rating (Moderate-Hi) lower than that attained by Subjects 14, 16, and 18.

Comparison of Scores on the Alcohol Use Inventory and the Video Game Questionnaires

Table 3-4 shows a comparison between subjects´ scores on the AUI and their scores on the Video Game Questionnaire. Subjects´ scores on both questionnaires were converted to Z scores. Then, the Video Game Questionnaire Z scores were subtracted from the AUI Z scores to obtain the Z score differences. A rank ordering of these difference scores predicts a rank ordering of alcohol consumption in the study. Subject 19 with the lowest difference score drank the least while Subject 18 with the highest difference score drank the most.

Expenditures and Purchases

Token Expenditures

Token expenditures on drinking and game playing per session, per subject, throughout the experiment are summarized in Figures 3-1 through 3-6. Subjects tended to spend all of their tokens with few exceptions. (This, of course, was not possible in Free Responding.) Visual inspection reveals that failure to spend all tokens occurred in Phase 2 for Subjects 6 and 19. These subjects did not always buy drinks with tokens remaining after purchasing the maximum of game playing time possible at a price of three tokens per six minutes. Subjects 11, 14, 16, and 18 failed to spend all of their tokens in as many as three sessions between Sessions 19 and 29.

Unit Purchases

The units purchased of drinking and game playing per session, per subject, are summarized in Figures 3-7 through 3-12. Unit purchases reflect subject acquisitions of opportunities to engage in a behavioral commodity. In this instance, subjects acquired opportunities to drink one drink (one unit of drinking) or to play a video game for six minutes (one unit of game playing). Unit purchases are proportional to expenditures at a given price. However, because unit purchases describe behavior, unlike token expenditures which describe the exchange medium, they formed the basis for the definition of stable responding. After an initial disequilibrium following most phase changes, stable responding was achieved for all subjects. Subjects tended to engage in all of their unit purchases, i.e., they tended to consume all of a drink purchased and to play all of the game time purchased. A few instances sporadically arose throughout the experiment, though, in which session time expired before the subject had completed engagement in one or the other of his purchases.

Game Playing

Number of Games Purchased per Token

Table 3-5 summarizes for each subject, in each phase, the number of games he played for each token he spent on game playing. These values show clearly the effect of price changes in each phase in terms of each subject´s purchase. For example, all subjects but Subject 11 obtained much less than one game for one token spent on game playing in Phase 4. In addition, to some extent, these values reflect individual skill level. As skill with the game increased, the subject played fewer games per six minutes purchased with tokens. This is easily visible in within subject comparisons of those phases with equal prices for game playing: Phases 1, Free Responding (FR), and Free Work (FW). For example, Subject 6 improved steadily in his game playing performance as shown by the decrease in the number of games per token from Phase 1 to Phase FR and Phase FW. Skill comparisons are also possible between subjects for those phases with equal prices for game playing: Phases 1, 2, FR and FW for all subjects, Phase 3 for all subjects except Subject 11, and Phase 4 for two groups of subjects, Subjects 14 and 16 as well as, Subjects 6, 18, and 19. For example, Subject 18 appears to be consistently the worst game player. Subject 16 appears to generally be the best.

Mean Game Duration

Figures 3-13 through 3-18 summarize mean game durations per session for each subject. These figures demonstrate individual subject skill and facility with game playing in more detail than was suggested by Table 3-5. Furthermore, they illustrate skill level without the influence of price changes. As subject´s skill in game playing increases, the duration of each game also increases. Visual inspection indicates that Subject 16 is the most skillful player while Subject 18 is the least skillful. Subject 6 shows a steady increase in skill, playing primarily STN until Phase 3 where his game durations decreased. He then changed games and again showed steady improvement while playing primarily DNL. Subject 11 shows a variable performance playing mostly STN until Phase 4 where his game durations also decreased. He then changed games and played DNL through Phases FR and FW at a fairly consistent skill level. Subject 14 played primarily DNL. He, like Subject 11, shows a variable performance that tends to remain above 75 seconds. Subject 16 shows highly variable performance which is peaked by increasingly longer games. After playing consistently well in Phase FR, he switched from playing primarily DNL to STN, but continues to show skill at this game. Subject 18 shows performance which, if he plays, steadily remains around 75 seconds. He played both games in Phases 1 and 2, but chose to play primarily STN in Phases 3 and 4. Subject 19 shows a steady increase in performance through Phase 1 playing both games. After that, he played primarily STN and shows highly variable performance that, for the most part, remains above 75 seconds. Like Subjects 14 and 16, he shows his highest level of performance in Phase 4.

Drinking

Drinking Behavior Purchased per Token

Table 3-5 discussed earlier in the context of game playing also summarizes for each subject, in each phase, the number of sips, the total duration of sipping, and the total duration of sitting in the drink area (with beverage in the glass) in which he engaged for each token he spent on drinking. There was considerable between subject variability in time spent consuming drinks. Subject 18 showed the most sips per token at eight in Phase 2 while Subject 16 showed the least at one in Phase FW. Subject 14 showed the longest sipping time per token in Phase 3 at 18 seconds, and Subject 16 again showed the least behavior per token in Phase FW at a sip duration of 5 seconds. When the measure of drinking behavior is drink area duration, Subject 6 obtained the least behavior at 36 seconds per token in Phase 2. Subject 18 showed the most at 536.2 seconds per token.

Sip Frequency

Figures 3-19 through 3-24 depict both the mean sip frequency per drink and the total sip frequency per session for each subject. The mean number of sips per drink both within and between subjects (when they did drink) was fairly stable in Phases 1 through 4. Subject 18, while demonstrating behavioral stability, generally engaged in a few more sips per drink than the other subjects. However, for those subjects who participated in Phases FR and FW, mean sip frequency per drink decreased somewhat. Sip frequencies per session show more variability as subjects varied the number of drinks they purchased.

Sip Duration

Figures 3-25 through 3-30 illustrate the mean sip duration per drink and the total sip duration per session for each subject. Mean sip durations per drink showed greater stability within subjects than between subjects. Subject 6 maintained the shortest mean sip duration per drink while Subject 18 maintained the longest. Sip duration per session showed more variability as subjects varied the number of drinks they purchased.

"Stereotypic Other"

Figures 3-31 through 3-36 show "stereotypic other" duration for each subject per session. During each session, behaviors which appeared to be repetitive and stereotypic were times. This was a global, fairly subjective estimate of other behavior which might include different behavioral classes from session to session. Those behavior classes which were timed are listed on the bottom of each figure. One behavior which appeared consistently after the onset of Phase 2 was sleeping. This behavior does not appear on any graph for any subject because the experimental space was not equipped to measure what, to the naked eye, appears as the absence of behavior. Subjects 6, 16, 18, and 19 developed stereotyped games which they played with the tokens after the onset of Phase 2. Subject 6 stacked and restacked the tokens. Subject 16 played a type of "tiddlywinks." Subject 18 not only stacked tokens, but built constructions out of them with his cigarettes as the supports. Subject 19 stacked tokens and stood them on edge to play a form of "dominoes." Playing with tokens formed a majority of these subjects´ timed stereotypic behavior. Subject 11 spent most of this time stimulating his hands and fingers, e.g., pulling, pinching, or stroking them. Subject 14 engaged mostly in wringing his hands and playing with the joystick while the game was off. As the price of game playing increased and subjects were therefore restricted in the amount of game playing in which they could engage, they increased engagement in repetitive, stereotyped behavior. Subjects 6 and 14, however, did a lot of sleeping so that their stereotypic behavior durations appear spuriously low.

Relationships Between Game Playing, Drinking, and "Other" Behavior

Area Duration

Figures 3-37 through 3-42 show drink area duration, game area duration and "area other" [session time--(drink area time + game area time)] duration per session for each subject. Whenever permitted by the contingency, subjects spent the majority of their time engaged in game playing. This is most obvious in a between subject visual comparison of Phases 1, FR, and FW. The pattern of responding to the contingencies in these three phases (with the exception of Subject 11 in Phase FW where he showed some anomalies) was strikingly similar, both between and within subjects. With changes in the contingencies via token price for game playing, however, between subject differences emerged. For instance, game playing tended to vary negatively with drinking. However, the extent of that variation differed between subjects in Phases 2 through 4. Subjects 6 and 19 showed little variation, where Subjects 11 and 18 showed relationships of much greater magnitude. "Area other" behavior tended to vary negatively with game playing and positively with drinking in Phase 1. This tended to remain the case throughout with the exception of Phase FR for Subject 11, Phase 4 for Subject 14 and Phases 3 and 4 for Subject 18. Again, the extent of the relationships differed between subjects. All subjects tended to show unstable responding following phase changes, although the degree of instability differed between subjects. Subjects 6 and 19, for example, showed little reaction to phase changes in contrast with Subjects 11, 16, and 18.

Numerical Cross Elasticity Estimates

Tables 3-6, 3-7, and 3-8 show cross elasticity estimates comparing the price of game playing with six measures of drinking--drink area duration, number of drinks, number of sips, sip duration, alcohol consumed (mls of vodka), blood alcohol level (immediately post session)--and with the three measures of other behavior--"area other" [session time-(drink area duration + game area duration)], "sip other" [session time-(sip duration + game area duration)], "stereotypic other". Cross elasticity estimates describe the extent of relationships between behaviors. Leftwich (1966) has algebraically determined the cross elasticity of commodity x with respect to a second commodity y such that:

$$\theta_{xy} = \frac{\Delta x/x}{-\Delta p_y/p_y} \qquad (1)$$

where θ_{xy} is the cross elasticity of commodity x with respect to commodity y, Δx is the change in the quantity engaged in of commodity x, x is the lower of the two quantities, Δp_y is the change in the price of commodity y, and p_y is the lower of the two prices of commodity y. If the two commodities are substitutable, θ_{xy} is negative. In the event that θ_{xy} is positive, the two commodities are complementary. High absolute values of θ_{xy} denote close relationships between the commodities, i.e., they vary together, while low absolute values denote remote relationships.

For example, Subject 18 from Phase 1 to Phase 2 spent 1938 seconds followed by 4370 seconds in the drink area. The price of game playing changed from one to three tokens. Therefore, Δx=1938-4370, x=1938, $-\Delta p_y$=-(1-3), p_y=1 such that:

$$\theta_{xy} = \frac{1938-4370/1938}{-(1-3)/1} = -.62 \quad .$$

Drink area duration functioned moderately as a substitute for game playing, i.e., they varied negatively.

For another example, Subject 18 from Phase 3 to Phase 4 spent 4725 seconds in the drink area followed by 1347 seconds. The price of game playing changed from 5 to 10 tokens. Therefore, Δx=4725-1347, x=1347, $-\Delta p_y$=-(5-10), p_y=5 such that:

$$\theta_{xy} = \frac{4725-1347/1347}{-(5-10)/5} = +2.50 \quad .$$

Here drink area duration functioned well as a complement for game playing, i.e., they varied positively.

The cross elasticity estimates indicate that drinking had no relationship with game playing for Subjects 6 and 19. Among the remaining subjects, the relationship was most remote for Subject 14, and the closest for Subject 18. Blood alcohol level and amount of alcohol consumed had the poorest relationship with game playing of the six drinking measures. Drink area duration generally has the best.

The cross elasticity estimates also indicate either very close or very remote relationships between game playing and "stereotypic other." This extreme variability is most likely due to the subjective difficulties encountered with this measure, not to mention the inability to measure sleeping accurately. "Area other" shows greater consistency than the latter, and generally higher values than "sip other."

The Elasticity of Game Playing

Numerical Own Price Elasticity Estimates

Table 3-9 depicts own price elasticity estimates comparing the price of game playing with both game playing units and the number of games played. Elasticity refers to the responsiveness of behavior to changes in environmental constraints, or price. It is measured as the ratio of the relative change in the amount of behavior allocation to the relative change in price under more than one set of circumstances (Nevin, 1974). Leftwich (1966) has employed an algebraic method of determining own price elasticity: arc elasticity. Arc elasticity computes ε between two separate points such that:

$$\varepsilon = \frac{\Delta x/x}{-\Delta p/p} \tag{2}$$

where Δx is equal to the lower of the two quantities minus the higher of the two quantities, Δp is equal to the lower of the two prices minus the higher of the two prices, x is equal to the lower of the two quantities and p is equal to the lower of the two prices. Elasticity is therefore a measure of the rate of change of p with x as a pure number, independent of the units of measurement of either x or p. The responsiveness of behavior to price changes is: a) more elastic where ε is greater than 1, b) more inelastic where ε is less than 1, and c) unitary where ε is equal to 1.

Elastic behavioral commodities are relatively responsive to changes in environmental constraints or price. For example, Subject 11 showed primarily elastic responding. As price increased, he reduced game playing and spent his tokens on the cheaper commodity, drinking. Comparing the change from Phase 1 to Phase 2, he purchased 30 units of game playing during the last three sessions of stable responding in Phase 1, followed by six units during the last three sessions of stable responding in Phase 2. Price in Phase 1 was one token per six minutes of game playing. Price in Phase 2 was 3 tokens. Therefore, $\Delta x = 6\text{-}30$, $x=6$, $\Delta p=1\text{-}3$, $p=1$.

$$\varepsilon = \frac{(6-30)/6}{-(1-3)/1} = \frac{-4}{2} = -2.0$$

Inelastic behavioral commodities are relatively unresponsive to changes in price. For example, Subject 14 tended to show inelastic responding. As closely as possible, he engaged in the same amount of game playing without regard to price. Comparing Phase 2 to Phase 3, $x=6\text{-}9$, $\Delta x=6$, $\Delta p=3\text{-}5$, $p=3$.

$$\varepsilon = \frac{(6-9)/6}{-(3-5)/3} = \frac{-.5}{.66} = -.75$$

Unitary commodities are moderately responsive to changes in price. Each change in price produces an equiproportional change in consumption with little change in spending. For example, Subjects 6 and 19 consistently spent as many tokens as possible on game playing. Therefore, as price changed, they continued to spend the same proportion of their income on game playing: as near to all as possible. Comparing Phase 3 to Phase 4, for Subject 6, $\Delta x=3\text{-}6$, $x=3$, $\Delta p=5\text{-}10$, $p=5$.

$$\varepsilon = \frac{(3-6)/3}{-(5-10)/5} = \frac{-1}{1} = -1.0$$

Elasticity is not fixed for a single commodity, but is subject to change by other factors (Hursh, 1980). For example, the availability of good substitutes tends to result in a commodity appearing more elastic (Leftwich, 1966). Pragmatically, most commodities demonstrate a mixture of elasticity, unitarity, and inelasticity. This is because as price approaches total income, spending tends to be redirected toward substitutes and therefore appears more elastic. As the commodity becomes cheaper, spending is reallocated from the substitute to the commodity and its complements until it shows unity. Eventually, it becomes so inexpensive, or has so few substitutes, that mild price changes are inconsequential to the "buyer." Variations in the elasticity of responding for the remaining subjects is interpretable in the context of substitution and complementation. The drink area, game area, and "area other" durations presented in Figures 3-37 through 3-42 and the unit purchases presented in Figures 3-7 through 3-12 can provide information about subjects´ substitutions and complementations via a visual inspection of negative and positive variation. However, cross elasticity estimations on Tables 3-6 and 3-8 calculated with drink area duration and "area other," (the best estimates of drinking and "other"), consolidate this information and make it possible to interpret substitution or complementation, as well as the extent of the relationship, on the basis of simple positive or negative numerical values.[1] (The calculation and interpretation of cross elasticity estimates was discussed above.). In the ensuing discussion, subject's own price elasticity for game playing is examined in the context of substitution or complementation by comparing changes in numerical own price elasticity estimates (Table 3-9) with changes in numerical cross elasticity estimates (Tables 3-6 and 3-8). Where subjects substitute or complement "other" behavior, "stereotypic other" information is used as an indicator of measurable "other" behavior. This information is found in Figures 3-31 through 3-36, and in Table 3-8, as well as in the attendant discussions.

Inspection of the first column of estimates on Table 3-9 (calculated with the total units purchased of game playing during stable responding) reveals that all subjects illustrated mixed elasticity to some extent. Subjects 6 and 19, however, demonstrate very limited variations in responding between phases. They consistently show close to unity responding, spending nearly all of their token income on game playing from phase to phase.

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[1] Area duration and unit purchase information confirms conclusions made through the use of cross elasticity estimates.

Subject 11 exhibited elastic responding (as mentioned above) and substituted other behavior for game playing as price increased from Phase 1 (one token) to Phase 2 (three tokens). As price decreased from Phase 2 to Phase 3 (two tokens), his responding became more unitary and he engaged in less substitution of other. He also began to increase his drinking as he increased game playing, i.e., he began to complement his game playing with drinking. In doing so, he spent less of his income on game playing. Price further decreased from Phase 3 to Phase 4 (one and one-half tokens). His responding changed little and thus appears mildly inelastic. Here, he substituted some drinking for game playing, but generally complements his game playing with a lot of cheap (free) other behavior.

Subject 14 showed slightly inelastic responding as price increased from Phase 1 (one token) to Phase 2 (three tokens). As price increased further from Phase 2 to Phase 3 (five tokens), his behavior changed little. The estimate again depicts inelasticity. He did not substitute drinking for game playing. His other behavior did not substitute well, either. Recall that he was the only subject besides Subject 11 who did not develop a stereotyped token game. Price increases from Phase 3 to

Phase 4 (eight tokens) did result in a mildly elastic estimate. However, this figure reflects some artifact. Token price permitted expenditure of all his income on game playing in Phase 3, but prohibited it by 20% in Phase 4. Since he spent as much income as possible in Phases 3 and 4, his behavior is more accurately described as showing unity.

Subject 16 demonstrated moderately elastic responding as price increased from Phase 1 (one token) to Phase 2 (three tokens). He heavily substituted both drinking and other behavior for game playing. However, as price increased from Phase 2 to Phase 3 (five tokens), his game playing behavior resisted and shows inelasticity. Apparently he found drinking unacceptable for further substitution. He did engage in some mildly increased substitution of other behavior. Another price increase from Phase 3 to Phase 4 (eight tokens) again produced moderately elastic responding. His sleeping increased in Phase 4, although his measurable other behavior and drinking remained the same.

Subject 18 exhibited unitary responding as price increased from Phase 1 (one token) to Phase 2 (three tokens). As price increased further from Phase 2 to Phase 3 (five tokens), his purchases of game playing became more elastic. In these phases, (1, 2, and 3), he substituted a lot of sleeping and spent nearly half of his tokens on drinking. However, as price increased from 50% of income in Phase 3 to 100% of income in Phase 4 (10 tokens), he appeared to substitute more measurable other behavior and the same amount of drinking for game playing. Neither appears to have been a good enough substitute, as his behavior was unresponsive to the price change and shows inelasticity. He would not substitute more than 50% of his game playing for either drinking or other. He managed this by spending all of his tokens on game playing one session, followed by spending most of them on drinking the next.

The second column on Table 3-9 depicts elasticity estimates calculated with the total number of games played during stable responding. Like the values in the first column, (calculated with the total units purchased of game playing during stable responding), the estimates in the second column show mixed elasticity for all subjects. However, the similarities end here. The values indicate simply that the number of games subjects played fluctuated from phase to phase during stable responding. No other logical interpretations are possible with these data.

Price Consumption Curves

Figures 3-43 through 3-48 show price consumption curves for each subject for comparisons of stable responding for the following phase pairs: 1 to 2, 2 to 3, 3 to 4. Price consumption curves have been described by Leftwich (1966) as a geometric means of evaluating elasticity. The ordinate represents the amount of income spent on drinking during stable responding for each of Phases 1 through 4. The abscissa represents the quantity of game playing units purchased during stable responding for each of Phases 1 through 4. The price of drinking remained stable at I_1/P_{y1}, which represents the proportion of income which can be spent on drinking. For all subjects, this is equal to:

$$\frac{I_1}{Py_1} = \frac{30}{1} = 30 \quad .$$

The proportion of income which could be spent on game playing in Phase 1 is represented by I_1/Px_1:

$$\frac{I_1}{Px_1} = \frac{30}{1} = 30 \quad .$$

In Phase 2, the proportion of income which could be spent on game playing for all subjects is equal to:

$$\frac{I_1}{Px_2} = \frac{30}{3} = 10 \quad .$$

The proportion of income which could be spent on game playing in Phase 3 for Subjects 6, 14, 16, 18, and 19 is equal to:

$$\frac{I_1}{Px_3} = \frac{30}{5} = 6 \quad .$$

For Subject 11 it is equal to:

$$\frac{I_1}{Px_3} = \frac{30}{2} = 15 \quad .$$

The proportion of income which could be spent on game playing in Phase 4 for Subjects 6, 18 and 19 is equal to:

$$\frac{I_1}{Px_4} = \frac{30}{10} = 3 \quad .$$

For Subjects 14 and 16 it is equal to:

$$\frac{I_1}{Px_4} = \frac{30}{8} = 3.75 \quad .$$

For Subject 11 it is equal to:

$$\frac{I_1}{Px_4} = \frac{30}{1.5} = 20 \quad .$$

Lines drawn connecting I_1/Py_1, to I_1/Px_1, I_1/Px_2, I_1/Px_3, and I_1/Px_4 represent changes in the available income wrought by the changes in the price of game playing. Subjects could make purchases along these lines or to the left of the lines, but not over the lines to the right. Points A, B, C, and D represent the quantity of game playing purchased by the subject at the appropriate price in Phases 1, 2, 3, and 4 with respect to the amount of income spent on drinking. The lines connecting Point A and Point B, Point B and Point C, Point C and Point D form the price consumption curves. Elastic responding is depicted by a curve sloping downward to the right. Subject 11, for example, shows elastic responding in all three curves. Unitary responding is depicted by a curve which forms a straight line. Subject 19, for example, shows unitary responding in Curve B-C, (Phase 2 to Phase 3), and Curve C-D (Phase 3 to Phase 4). Inelastic responding is depicted by a curve sloping upward to the right. Subject 16, for example, shows inelastic responding in Curve B-C (Phase 2 to Phase 3).

The price consumption curves for each subject show changes in responding identical to those described earlier for estimates in Table 3-4 (calculated with units of game playing) with one exception. Subject 11´s responding appears mildly elastic from Phase 3 to Phase 4 on the price consumption curve, but mildly inelastic on the numerical estimate. The price consumption curves, therefore, provide support for the numerical elasticity estimates in an easily interpretable, graphic manner.

Choices Under Constraint Compared with Conditions Analogous to Free Responding

Preference Packages

Figures 3-49 through 3-53 show preference packages chosen per phase by subjects who participated in Phases 1 through FR. (Subject 18 did not participate in Phase FR.) Rachlin, Battalio, Kagel, and Green (1981) have described a graphic means of evaluating the relationship between two behavioral commodities under constraint and without constraint (free responding). The ordinate represents drink area duration in seconds during the stable responding. The abscissa represents game area duration in seconds during stable responding. Lines I, II, III, and IV show the attainable combinations of drink area duration and game area duration in Phases 1 through 4 during stable responding. For example, Line I depicts all possible combinations of drink area duration and game area duration during Phase 1 stable responding. At a token price of one for both commodities, subjects could spend all of their three stable responding sessions, 10800 seconds, engaged in either game playing or drinking. Whatever duration was spent in one activity could not be spent on the other, so that if half of the time was spent game playing, no more than half of the time could be spent drinking. Line II, for another example, shows all possible combinations in Phase 2. Here, drinking remained at a token price of one. Subjects could continue to spend all of their 10800 seconds engaged in drinking. Game playing, however, was now constrained at a cost of three tokens per six minutes.

Subjects could only spend a maximum of 3240 seconds in game playing.

Points A, B, C, D, and E show the preferred packages of drinking and game playing chosen by each subject in each of the five phases. Each point represents a _proportion_ of game area duration to drink area duration. Points A, B, C, and D could fall on, or to the left of, the lines of attainable combinations for Phases 1, 2, 3, and 4--Lines I, II, III, and IV respectively. For example, Phase 2 attainable combinations are shown by Line II. Point B shows the proportion of game playing and drinking durations chosen in Phase 2 stable responding. In Phase 2, Subject 11 spent 2160 seconds in the game area and 5343 seconds in the drink area during stable responding. His choice, Point B, falls on Line II.

Point E shows the package chosen by subjects in Phase FR. The only limits on behavior in Phase FR were those imposed by session time because subjects were given more tokens than they could possibly spend. Point E, therefore, could fall on, or to the left of, Line I. (Recall that Line I allowed _all_ of the session time to be spent on either game playing or drinking.)

The relationship between Point E and Points A through D illustrates the relationship between free responding and responding under four different constraints. For all subjects, choice packages in Phase FR fall closer to choice packages in Phase 1 than any other Phase. For Subject 6 they are identical and for Subject 19 they are nearly identical. Subject 14 and 16 show mild differences in their choices for the two phases. Subject 11, (who showed the greatest elasticity of responding), demonstrated a surprising increase in drinking behavior from Phase 1 to Phase FR, suggesting that he preferred to drink more than the constraints on access via a token price of one and a fixed income would allow. With the exception of Subject 14, (who showed the most inelasticity of responding), all subjects demonstrated greater engagement in drinking when their two behavioral commodities were under constraint than when they had free access in Phase FR. Subject 14 showed the most drinking behavior in Phase FR, suggesting that he preferred to increase his drinking as he increased his game playing in a complementary fashion.

Income Consumption Curves

Figures 3-54 through 3-57 depict income consumption curves for subjects who participated in Phase 1 and Phase FW. (Subjects 14 and 18 did not participate in Phase FW.) Income consumption curves, as described by Leftwich (1966) provide a method for evaluating subject responding when income is changing. To obtain the price consumption curve for a commodity, the price is held constant and income is allowed to vary. The ordinate represents the amount of income spent on drinks during stable responding in Phases 1 and FW. The abscissa represents the quantity of game playing engaged by the subject during stable responding in Phases 1 and FW. Between the two phases, price remained constant for both commodities at one token per unit. Income was permitted to vary from 30 tokens to that determined by each subject´s preference. The proportion of income that could be spent on drinking at the two income levels is depicted by Point I_1/Py_1 and Point I_2/Py_2. Two lines are drawn connecting each of these points to the points representing the proportion of income that could be spent on game playing at income 1, Point I_1/Px_1 and income 2, Point I_2/Px_2. These lines show the change in the line of attainable combinations of the two behavioral commodities wrought by the change in income. For example, Subject 16 changed his income from 30 in Phase 1 to 38 in Phase FW, such that:

$$\frac{I_1}{Px_1} = \frac{30}{1} = 30 \qquad \frac{I_2}{Px_2} = \frac{38}{1} = 38$$

$$\frac{I_1}{Py_1} = \frac{30}{1} = 30 \qquad \frac{I_2}{Py_2} = \frac{38}{1} = 38 \quad .$$

The increase from one income to another shifted the line of attainable combinations to the right and parallel to the original one. The coordinates (x_1, y_1), Point A, illustrate the quantity of game playing engaged in at income level 1 with respect to the amount of income spent on drinks. Point B, coordinates (x_2, y_2) represents the quantity of game playing engaged in at income level 2 with respect to the amount of income spent on drinking. Subject 16 spent four tokens on drinks and purchased 26 units of game playing in Phase 1. He spent eight tokens on drinks and purchased 30 units of game playing in Phase FW, such that:

$y_1 = 4$ $y_2 = 8$

$x_1 = 26$ $x_2 = 30$.

The line connecting Points A and B forms the income consumption curve which depicts changes in the subject´s preference packages as income is varied.

Only Subject 16 chose to earn a different income in Phase FW than he was given (30 tokens) in Phase 1. All other subjects seem to have been satisfied to work for only 30 tokens during stable responding. Their preference packages show very mild, if any, differences between the two phases.

CHAPTER IV
DISCUSSION

The results of the experiment provide suggestions for further research, and support for the study´s theoretical underpinnings. These issues will first be addressed in this chapter as they arise in the context of questionnaire data and elasticity estimates. Discussion will then focus upon issues related to area durations, the assessment of "other," the use of tokens, and skill. Conclusions and suggestions drawn from the inclusion of Phases FR and FW as well as from the use of a single subject design will be addressed last.

Questionnaires

The drinking questionnaires predicted little when interpreted alone. The Drinking Practices Questionnaire (Cahalan, Cisin, & Crossley, 1969) showed differences between subjects which were unrelated to subject´s drinking behavior in the study. Subjects within the same category of alcohol consumption on the questionnaire showed markedly different choice and consumption patterns in the study. Subjects´ responding on the Alcohol Use Inventory (Mehrabian & Russell, 1978) all fell within one standard deviation from the mean for college student norms. The raw scores did, however, predict the two subjects, (Subjects 6 and 19), who consumed the least alcohol in the study. Otherwise, the scores fail to predict consumption and choice patterns. Note, however, that neither of these indicators were constructed for this purpose. They were designed to assess alcohol consumption in vivo. The Video Game Questionnaire similarly demonstrated an inability to predict subjects´ choice behavior in the study. The latter was not surprising as no data exist concerning the usefulness of this scale. What was surprising was that a comparison of scores on both the Alcohol Use Inventory and the Video Game Questionnaire did predict alcohol consumption in the study. The Z score differences in Table 3-4 rank ordered the subjects perfectly from those who drank the least to those who drank the most.

This finding suggests that patterns of alcohol consumption are not dependent solely upon the reinforcing value of drinking. Instead, it suggests that a preference structure exists for individuals between drinking and other reinforcing activities. Whether or not the behavioral context allows access to activities other than drinking, and whether these activities are preferred more or less than drinking determined alcohol consumptive choice behavior. This is a central point in an application of behavioral economic theories of choice to an analysis of alcohol consumption (c.f. Vuchinich, 1982; Vuchinich & Tucker, 1983). However, the finding suggests further that preferences and preference structures may be assessed via self report instruments. The development of paper and pencil inventories which would predict changes in drinking behavior with changes in the availability of other reinforcing activities could be of tremendous benefit in developing effective, individualized, treatment regimens.

Elasticity Estimates

Price Effects

The elasticity estimates show the responsiveness of each subject´s behavior with each change in the price contingency for game playing. Some of the variations in responsiveness seen in the study were due directly to the effects of changes in price. This can best be seen in the pattern of numerical elasticity estimates shown by most subjects. With the first price increase, subjects predictably showed some degree of elastic responding. (Recall that as price approaches total income, responding tends to become more elastic.) As price increased again, though, artifact and other variables overrode the effects of price just enough for those subjects´ responding to show a trend toward inelasticity. The final price increase was large enough to generally prevail against those extraneous variables and forced the subjects´ behavioral responsiveness closer to elasticity.

Preference Structure Effects

Changes in price and artifact account for only a portion of the variation in elasticity estimates. The remaining variation appears to be due primarily to the influence of pre-existing, individualized, preference structures for the activities available in the experiment. These preference structures appear to have affected subjects´ willingness to give up game playing in exchange for "other" behavior or drinking. Preference structures are therefore expressed as a personal style of elastic responsiveness to changes in the price of game playing, dependent upon a similarly personal style of complementation and substitution of "other" behavior and drinking. What follows here is a brief description of the effects of preference structures on the choice behavior of each subject as inferred from a concurrent interpretation of elasticity estimates with cross elasticity estimates obtained from "area other," stereotypic "other" duration, and drink area duration. (Recall that cross elasticity estimates show patterns of substitution and complementation.)

Like all subjects, Subjects 6 and 19 clearly preferred game playing over any other available commodities in the experiment. They, and all other subjects, demonstrated a preference structure which allowed substitution between cheap, (free), "other" behavior and game playing. However, these two subjects did not develop a preferred, ritualistic behavior which could seriously compensate for game playing in their preference structures. Furthermore, drinking was not a preferred activity at all, and it existed entirely without any relationship to game playing. As a result, the two subjects made the only choice available to them throughout the experiment. Regardless of the price, they continually spent all, or nearly all, of their income on game playing, which was reflected in consistently close to unity elasticity estimations.

Subject 14 also failed to develop a preferred, ritualistic behavior which could offer much in the way of compensation for game playing in his preference structure. Drinking for him was a mildly preferred activity, but only when he could complement it with game playing. His lack of a good substitute for game playing combined with a loss of preferred status for drinking without game playing dictated his choices. He attempted at all costs to maintain the same amount of game playing, which was reflected in fairly consistently close to inelastic elasticity estimations.

Subject 18 developed ritualistic behavior, but clearly ranked it as a poor substitute for game playing. Drinking for him was a preferred activity, (indeed he drank the most of any subject), but his preference structure seems to have ranked it almost equally with game playing. As a result his choices to drink fluctuated around an attempt to maintain a proportional relationship between drinking and game playing. In Phase 4, he alternately drank and game played between sessions rather than make a dichotomous choice at a price (10 tokens) which prohibited some of each behavior within sessions. His choices are reflected in elasticity estimates which lean towards unity.

Subject 16 did develop a preferred, ritualistic behavior which compensated him fairly well for game playing. Drinking was also a preferred activity for him which substituted, not as well as ritualistic behavior, but better than it did for any of the other subjects. All in all, though, his preference structure does not appear to permit more than moderate substitution between any of the available activities. He shows this tendency toward moderation in mixed elasticity estimates which depict his limit setting for substitutary engagement.

Subject 11 developed ritualistic behavior which he not only preferred, but which he substituted fluently with game playing. For him, drinking could also function as a substitute for game playing in his preference structure, but only within limits. His preference structure, overall, therefore, allowed more substitution than did any other subject´s. The tendency he displayed toward easy substitution was reflected in elastic elasticity estimates.

The preceding discussion describes within subject consistencies in choice behavior which appear to be the result of individualized preference structures. Changes in contingencies did not appear to alter these structures. Instead, individualized preferences seemed to alter responsiveness to changes in contingencies. For most subjects, alcohol consumption appeared to be a preferred behavioral commodity which substituted, or complemented, with other available behavioral commodities. The preference structure `status´ of alcohol consumption with respect to other behavioral commodities was fairly stable as well as idiosyncratic. Changes in the availability of game playing therefore influenced engagement in drinking dependent upon the nature of the relationship between the two as dictated by each individual´s preference structure.

A few implications for the development of treatment regimens targeting alcohol consumption are evident. First, the stability of preference structures under the influence of changes in contingencies suggests that attempts to alter the preference `status´ of drinking are unlikely to succeed in producing long term changes. Second, that alcohol consumption is likely to function as a substitute or complement with other behaviors within an individualized/idiosyncratic preference structure indicates that successful intervention should include 1) assessment of, and changes in, the availability of other, preferred behavioral commodities and 2) careful assessment of the relationship between these commodities and drinking as dictated by the individual´s preference structure (c.f. Vuchinich, 1982). Accordingly, treatment intervention should involve not only techniques designed to decrease drinking, but techniques designed to increase substitutable behaviors and decrease complementary behaviors. These interventions should be highly individualized as substitutable behaviors for some, may be complements for others. For example, attempts to increase social interaction might allow certain persons to decrease drinking by way of substitution. Other persons might increase drinking as they increase social interaction if the two behaviors function as complements.

Area Duration

As indicators of choice behavior, drink area duration, game area duration, and "area other" were the three best measures. This was illustrated nicely by the ease with which variations in drink area duration and "area other" cross elasticity estimates allowed an interpretation/description of variations in game area duration own price elasticity estimates. None of the remaining measures from the three behavioral domains assessed in the study (drinking, game playing, "other") demonstrated as good of a fit. There are two probable reasons for the superiority of these three measures over all of the remaining measures. The first reason stems from the comparability of game area duration with drink area duration and "area other." All three are fairly global measures of behavior which can be equated on the basis of time (c.f. Premack, 1965; Baum & Rachlin, 1969). Had a more reductionistic measure of game playing proved to be as interpretable as game area duration (e.g., number of games played per session), one of the more reductionistic measures of drinking (e.g., sip frequency per session), or of "other" (e.g., stereotypic behavior duration), might have been as interpretable as drink area duration and "area other." As it was, however, the less global measures of game playing varied due to factors not closely associated with choices between drinking, "other," and game playing. Specifically, time spent playing each game and number of games played per session were influenced strongly by skill and confounded by the subjects´ propensity toward "killing off their men" to provoke the beginning of a new game.

The second probable reason for the superiority of drink area duration, game area duration, and "area other" over the remaining measures is the amount of session time for which an account could be made. The use of these three mutually exclusive measures, in combination, account for 100% of session time. That a combination of mutually exclusive variables which account for total observation time provides the best description of choice behavior has been discussed by Rachlin and Burkhard (1978).

The Assessment of Other

"Area other" constitutes something of a large wastebasket category which provided little detailed information about variations in a number of behaviors (besides drinking and game playing) exhibited in sessions. That these behaviors are important in an analysis of choice is illustrated by anecdotal evidence concerning Subject 18. This subject was the only smoker in the study. At the beginning of Phase 2, he arrived at every other session without his cigarettes. During these sessions, he noticeably drank less and played games more. Accordingly, his behavior between sessions was quite variable. He was then asked to either bring cigarettes to each session or to refrain from smoking in all sessions; he decided on the former. His behavior immediately stabilized.

Stereotypic behavior duration was a rough attempt to assess "other" behaviors more specifically. Much of this measure's failure to provide easily interpretable information was due to its inability to include sleeping. All subjects spent at least some of their session time sleeping in Phases 2 through 4. (Some subjects spent the majority of their time sleeping in these phases.) Nevertheless, with all its shortcomings, it was impressive that the measure provided as much useful information as it did with as few behavior classes as were timed per subject. This indicates that, in future research, more specific attempts might be made to measure "other" behavior. Observational information suggests two potentially feasible approaches. Either or both approaches to measurement of "other" behavior would allow a more precise analysis of the variations in behavior-behavior relationships which form a central aspect of maximization theory.

The first possible approach to an improved assessment of "other" behaviors might involve the use of the observation that "other" behavior was displayed in patterns. "Other" behavior tended to occur (1) with increasing frequency as the price of game playing increased, 2) immediately after each sip, and 3) immediately before token expenditure. In addition, "other" behaviors had a ritualistic quality to them which allowed fairly easy identification and timing. For example, Subject 16 tended to tap his hand and/or foot rapidly before token expenditure. If he purchased a drink, he then wiggled his toes, foot, and/or leg immediately after each sip. Before spending another token, he usually engaged in playing with the tokens until he had flipped all 10 tokens 10 times. (He and other subjects with token games would often take them out of the token receptacles.) Utilizing this information, experimenters could anticipate the display of 1) "other" behavior to increase as the price of game playing increased, 2) token games (which most subjects displayed), and 3) ritualized behavior between token expenditures and after sips. Because of the ritualized nature of "other" behaviors, provisions could be made to label and time a number of them (about 10 should be adequate) separately for each subject.

The second possible approach to an improved assessment of "other" behaviors might involve the use of different observations. Subjects very rarely left either the drink area or the game area until they had completely consumed their unit purchase.[1] That is, subjects tended to clump their behavioral engagement into the units provided. After purchasing game playing they played continuously for the six minutes allotted them, and after purchasing a drink they sat sipping until the glass was empty. In addition, game and drink area durations proved to be good indicators of choice behavior. These observations suggest that subjects might be given more behavioral options in the form of activity areas, e.g., a sleep area, a token play area, a magazine reading area. "Other" behavior could then be reduced as a nonspecific measure because these alternative activities would hopefully capture a great deal of the subjects´ behavior. Participation in alternative areas could be measured via duration. The advantage of this second approach over the first is that it provides a fairly straightforward method of assessing sleeping--a behavior in which all subjects engaged.

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[1] Subject 18 did not display this pattern. He tended to play one game and then move to the drink area where he would take a few sips before returning to the game area. However, he did clump his behavioral engagement, so to speak, albeit with different units. He also engaged in "other" behavior as did all remaining subjects, i.e., other behavior was displayed immediately after each sip and immediately before token expenditure.

Tokens

A Medium of Exchange

The use of tokens as a medium of exchange in this experiment raises two issues for discussion: the value of the tokens as a secondary reinforcer and their value in terms of purchasing power. Anecdotal evidence indicates that the tokens took on value as a secondary reinforcer, much like that of money. With each increase in price, all subjects complained, argued with the experimenter, and threatened to drop out of the experiment. This was in contrast to behavior observed at the onset of Phase FR when subjects laughed, threw tokens around the room, then carefully counted, arranged, or stacked them. At about the twentieth session, each subject began to express unwillingness, both verbally and behaviorally, to spend their last token. All subjects developed a pattern of saving tokens for expenditure during the last possible minutes of the session. This was not as surprising as the behavior of Subjects 11, 14, 16, and 18 who on a few occasions did not spend all of their tokens and who each attempted to "steal" one. When asked about their pattern of expenditure and their unwillingness to spend the last token, all six subjects explained, (in almost identical language), that it was much like the experience of not wishing to spend one´s "last dime." In as much as tokens had no value outside of the experiment and could be exchanged only during the session in which they were earned, these behaviors constitute interesting side effects which should be explored methodically in further research.

Purchasing Power

In terms of purchasing power, tokens tended to purchase more game playing behavior than drinking behavior. Inspection of Table 3-3 and comparison of the 360 seconds (6 minutes) of game playing received per token with any measure of drinking behavior duration shows this tendency. It appears that subjects did not attempt to stretch out their sip durations which remained fairly stable throughout the experiment. They did, however, appear to develop skill in stretching out their drink area duration; subjects who drank more often increased the time they spent sitting with beverage in the glass. Only one subject (Subject 18) was able to extend his drink area duration per token consistently equal to or beyond that allotted for game playing per token. He chose to drink more frequently than any other subject. The suggestion is, then, that game playing may have been consistently chosen over drinking by all subjects because of the existing imbalance in the durations purchased per token between the two behaviors. In other words, game playing captured most of the subjects´ behavior because they got more behavior for a token spent on game playing than they did drinking. Future experimentation might utilize this information to increase the purchase power of tokens spent on drinking by a) conducting 30 minute instead of 60 minute sessions and lowering the unit duration of game playing from 6 minutes to 3 minutes, or b) increasing the volume of the alcohol drink 100% by adding more orange juice or by offering beer or wine as drinks. These changes might make drinking behavior per token more equivalent to game playing per token.

Skill

Skill and Choice Behavior

Skill at game playing clearly increased for all subjects as the experiment progressed. Subjects who played least demonstrated lower levels of skill, while subjects who played most demonstrated higher levels of skill. However, the relationship between skill and choices to engage in game playing is questionable. Whether subjects who played poorly felt frustrated and chose game playing less often, or whether subjects who played less often gained less practice and so played poorly is unknown. Similarly unknown is the direction of the relationship between a change in the game chosen for play and the previous slump in performance observed for some subjects. The slump might indicate either a frustrating inability to perform as they did previously, or a lack of attention due to boredom with the task. When asked about their behavior, subjects tended to verbalize a confusing array of reasons which denied awareness of their continued choice of game playing over drinking.

Skill and Price

Skill and price also demonstrated a relationship. As price increased, all subjects except Subject 18 demonstrated increased skill. With the decreased price relative to income constraints (Phases FR and FW), subjects' game playing skill level decreased. This relationship also held true for skill at stretching out drinking; in Phases FR and FW, subjects tended to decrease their drink area duration per token. Perhaps subjects simply tried harder to utilize the behavioral commodities as their value increased as a result of price increases. The relationship suggests, in any case, that to some extent, demonstrations of skill are under the influence of decreases in the availability of commodities. Specifically designed research may further explore and elucidate the relationship.

Phases FR and FW

The addition of Phases FR and FW to the experiment yielded little information. The results obtained from these phases do, however, allow a few interpretations. Choice behavior under the conditions imposed by Phases A, FR, and FW was essentially the same both within and between subjects. This suggests, first, that there was no noticeable effect for the imposition of an operant requirement for the acquisition of tokens, when time spent performing the operant was not included in the session time. Second, the similarities observed in behavior under Phases 1, FR and FW suggests that because all subjects preferred game playing over drinking, each subject spent the maximum amount of time possible game playing. Third, because Phases FR and FW were temporally distant from Phase 1, it indicates that the choice behavior exhibited in these and all other phases was due primarily to the imposed contingencies, and not the influences of time or observation. Fourth, the lack of variation in choice behavior in Phases 1, FR, and FW or contrasted with the between subject variation observed in Phases 2 through 4, suggests that behavior under conditions analogous to free responding is not predictive of choice behavior under constraint. This last conclusion is at variance with conclusions drawn by other authors (c.f.

Premack, 1965). Nevertheless, it highlights the importance of observing behavior under more than one contingency for the determination of preference structures, as has been suggested by Rachlin et al. (1981).

The Single Subject Design

The single subject design employed in this experiment has allowed a detailed analysis of individual behavior in the experimental context. The data obtained through multiple measurements on a few individuals has not only been interpretable, but has yielded a great deal of fine grain information. Much of this information would have been obscured by the complicated statistical maneuvers required by group designs which allow only an examination of gross differences between groups. The detailed information availed by the design of this experiment has generated numerous, fairly obvious suggestions for further research. Many of these proposals have already been discussed. At this point, a few more indications for continued research efforts will be presented for consideration.

Single subject design methodology requires that issues of generalizability be addressed by replication (Johnston & Pennypacker, 1980). The first steps in that process should involve direct replication with more homogeneous populations. One way of accomplishing homogeneity might be to choose subjects whose scores on the Alcohol Use Inventory and the Video Game Questionnaire reflect a similar pattern. For example, only persons who scored higher on the former than on the latter might serve as subjects. Along a similar vein of thought, replication might be attempted with selected patient populations, e.g., problem drinkers or hospitalized "skid row alcoholics." It is hoped that this approach might not only provide information about the generalizability of the findings, but about significant subgroups in the population which might be useful for diagnostic and/or treatment purposes. For example, persons displaying certain patterns of choice behavior may be more at risk or display a better prognosis for alcohol problems.

Replications examining choice behavior with behavioral commodities other than drinking and game playing might also yield useful information which addresses the issue of generalizability. On the surface, drinking and game playing appear to be unrelated activities. However, they were found to demonstrate relationships in the experimental context. Changes in the availability of game playing influenced engagement in drinking, dependent upon the nature of the relationship between the two as dictated by each individual´s preference structure. It would seem that if these two activities can demonstrate a relationship, the possibilities for discovering relationships between other activities are truly intriguing.

APPENDIX A

PILOT STUDY

Purpose

The Pilot Study was conducted in order to determine the feasibility of the main experiment. It was designed as a mimic of Phase 1 so that any major procedural difficulties could be addressed before the main experiment was begun. The pragmatic issues it addressed were as follows: 1) inter-rater reliability, 2) the ability of the video games to engage the subject´s behavior, 3) the possible effect of game preference and the availability of one or two games on behavior, and 4) the overall stability of subjects´ behavior between sessions.

Method

Experimenters

All of the initial experimental sessions were conducted by the author, who also administered all questionnaires. Other experimental sessions were conducted by the author and one of three trained assistants.

Subjects

Six male college students whose ages ranged from 21 to 29 served as subjects. Each subject participated on an individual basis. None of these subjects participated in any of the other phases. They were recruited, selected, and paid just as they were in the main experiment.

Experimental Setting

The experimental setting was identical to that used in the main experiment.

Procedures

The first one hour session of the Pilot Study was conducted exactly as was the first session of Phase 1.

The second one hour session proceeded exactly as did the first, with one exception: only one game was made available, STN. This game could be programmed for several levels (0-15) and subjects were permitted to change levels at any time by notifying the experimenter.

The third one hour session proceeded as did the second, with the exception that only the other game, DNL, was made available. (This game permits the player to advance through levels 0-9 only via his performance.)

The fourth one hour session proceeded as did the first, with both games (STN and DNL) and/or levels available to the subject. Transcripts of instructions given to subjects in the second, third, and fourth session of the Pilot Study are included in Appendix B.

During the second, third, and fourth sessions of the Pilot Study data were accumulated just as they were in the main experiment.

Results

The results of the Pilot Study are summarized in Tables A-1 through A-2, and in Figures A-1 through A-12. Table A-1 depicts the percent agreement of observation between the primary investigator and each of the three assistants for the three sessions in which data were recorded. The values indicate high inter-rater reliability. The comparatively low values for sip durations were found to be, in part, due to the angle of the rater´s views of subjects. Accordingly, adjustments were made in the angle of the drink area chair and in the position of the experimenters.

Figures A-1 through A-6 illustrate the number of tokens spent on either drinking or game playing during each session for each subject. In general, subject´s behavior appeared fairly stable between sessions. All subjects but one demonstrated stable responding. (Stable responding was defined as no deviation among three successive sessions greater than one unit of behavior on game playing. This is the same definition used in the main experiment.

Table A-1. Percent Agreement for Pilot--Primary Investigator with Each Assistant.

Measure	Assistant 1	Assistant 2	Assistant 3
Total duration of game playing	99%	99%	99%
Number of games played	100%	100%	100%
Duration of playing for each game	99%	99%	99%
Total duration in the drink area	99%	98%	98%
Total sip frequency	98%	99%	98%
Total duration of sipping	90%	86%	87%
Mean sip frequency per drink	99%	99%	98%
Mean sip duration per drink	91%	86%	87%
Total duration in the work area	99%	99%	100%
Total duration of "other than" behavior: session time - (total duration in the drink area + total duration of of game playing	99%	98%	99%
Total duration of "other than" behavior: session time - (total duration of sipping + total duration of game playing	98%	99%	99%

Table A-2. Token Expenditures on Drinks for Pilot.

Subject	Game	Tokens Spent on Drinks
2	Preferred (DNL)	3 and 2
	Non Preferred (STN)	4
3	Preferred (STN)	4 and 4
	Non Preferred (DNL)	5
4	Preferred (DNL)	4 and 3
	Non Preferred (STN)	3
5	Preferred (DNL)	2 and 2
	Non Preferred (STN)	2
7	Preferred (DNL)	2 and 2
	Non Preferred (STN)	2
8	Preferred (DNL)	2 and 4
	Non Preferred (STN)	2

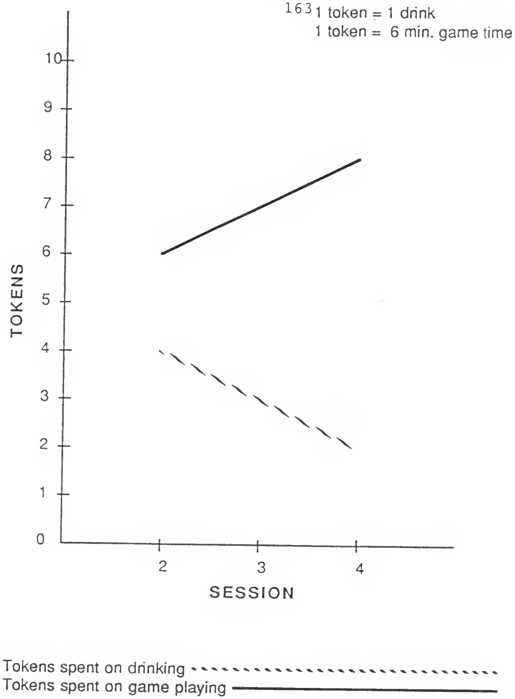


Figure A-1. Subject 2--Token Expenditures on Drinking and Game Playing per Session for Pilot.

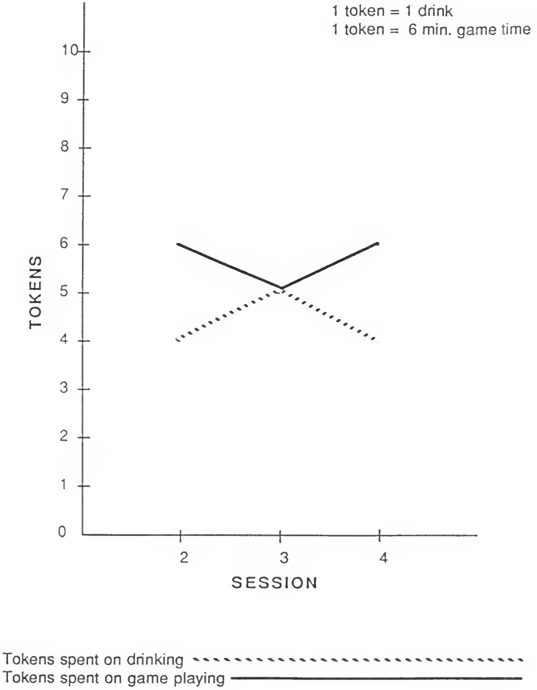


Figure A-2. Subject 3--Token Expenditures on Drinking and Game Playing per Session for Pilot.

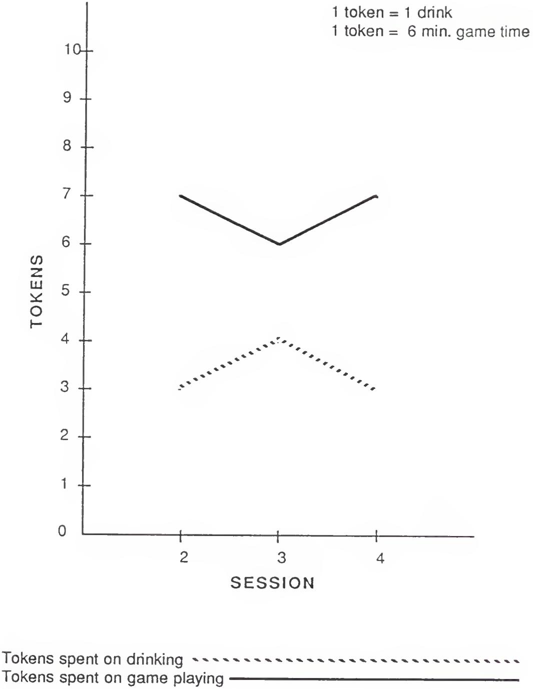


Figure A-3. Subject 4--Token Expenditures on Drinking and Game Playing per Session for Pilot.

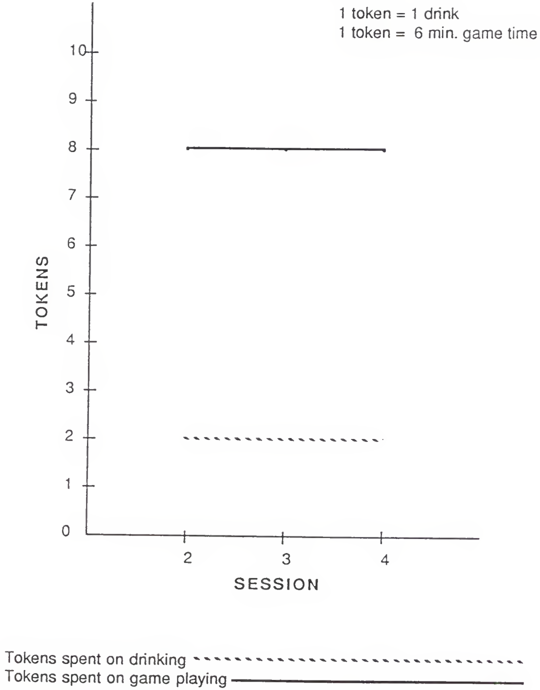


Figure A-4. Subject 5--Token Expenditures on Drinking and Game Playing per Session for Pilot.

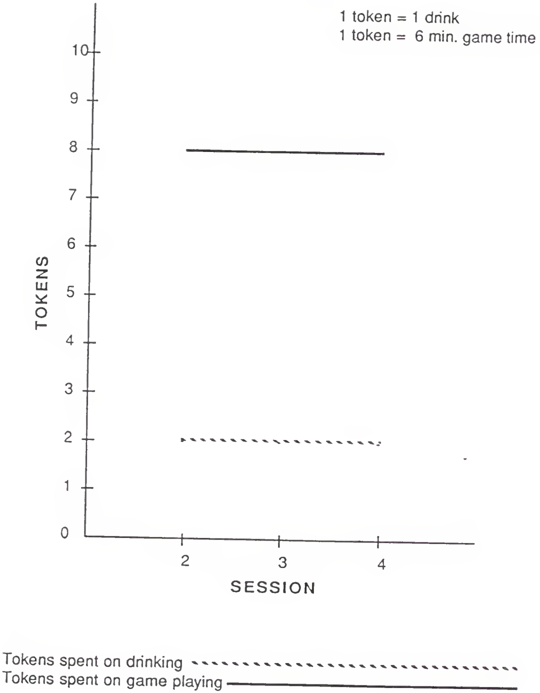
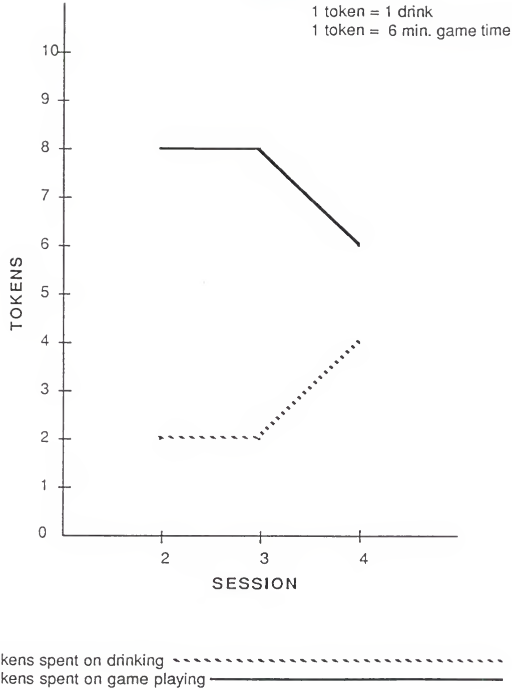


Figure A-5. Subject 7--Token Expenditures on Drinking and Game Playing per Session for Pilot.



1 token = 1 drink
1 token = 6 min. game time

Figure A-6. Subject 8--Token Expenditures on Drinking and Game Playing per Session for Pilot.

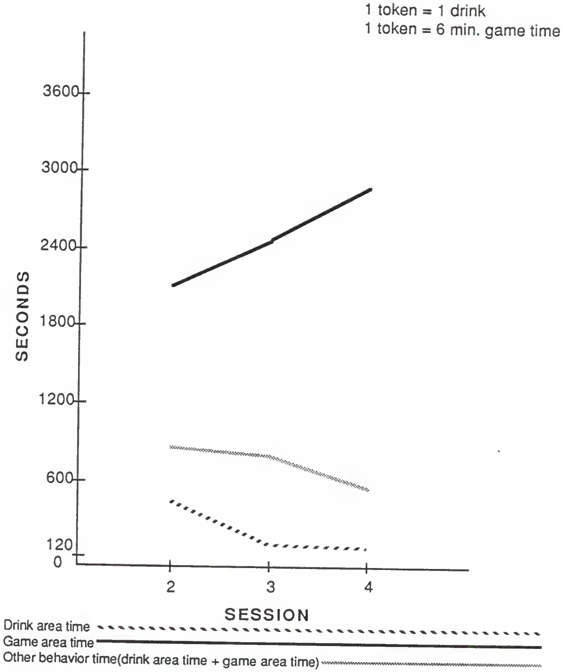


Figure A-7. Subject 2--Drink Area, Game Area, and Other Duration per Session for Pilot.

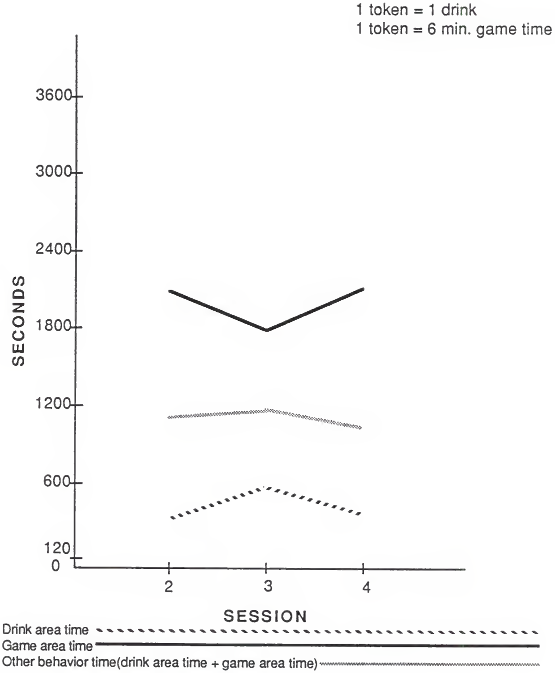


Figure A-8. Subject 3--Drink Area, Game Area, and Other Duration per Session for Pilot.

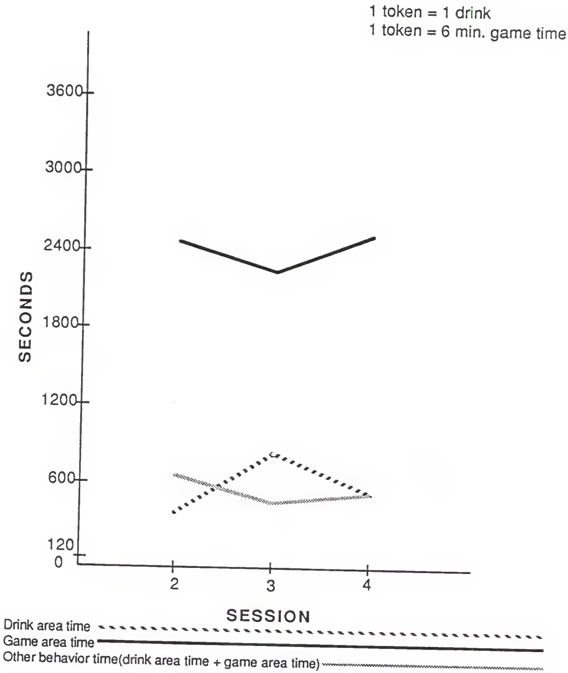


Figure A-9. Subject 4--Drink Area, Game Area, and Other Duration per Session for Pilot.

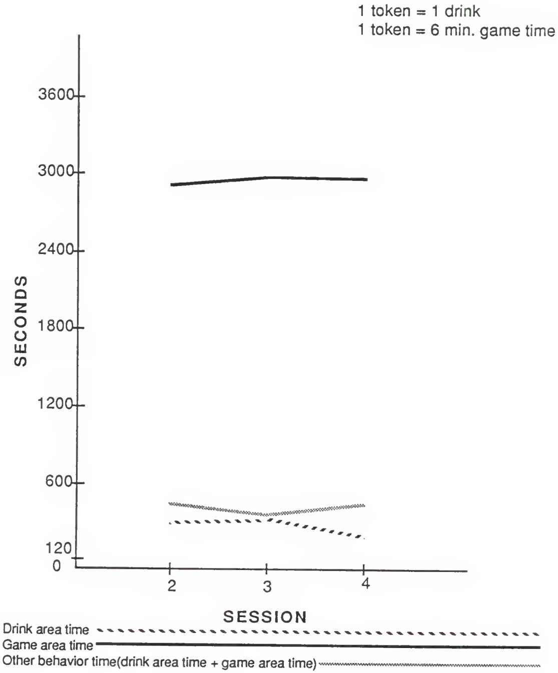

1 token = 1 drink
1 token = 6 min. game time

Figure A-10. Subject 5-Drink Area, Game Area, and Other Duration per Session for Pilot.

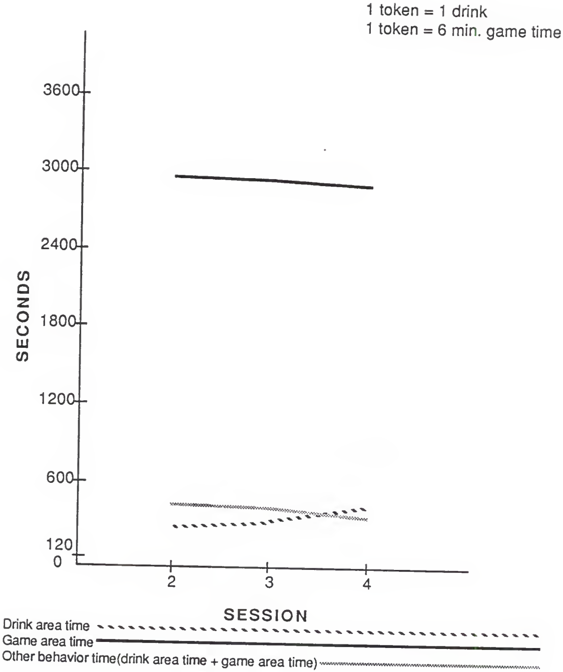


Figure A-11. Subject 7-Drink Area, Game Area, and Other Duration per Session for Pilot.

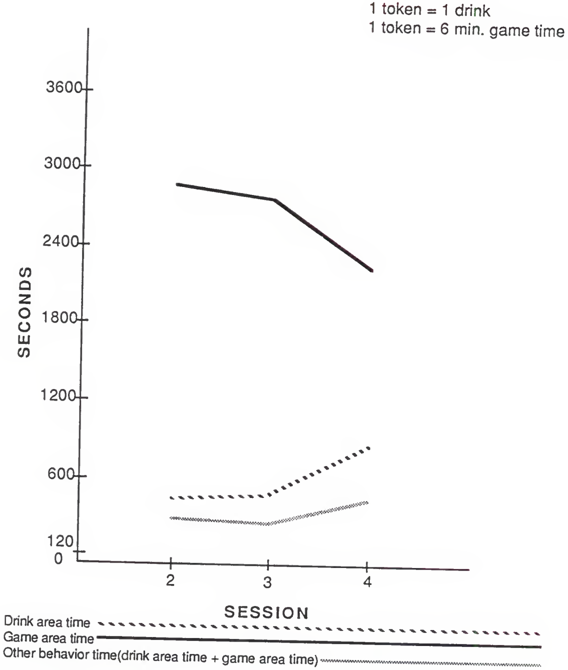


Figure A-12. Subject 8-Drink Area, Game Area, and Other Duration per Session for Pilot.

Figures A-7 through A-12 show the duration in seconds each subject spent in the drink area, game area, or other [session time - (drink area duration + game area duration)] during each of the three recorded sessions. These data clearly indicate that not only were subjects engaged in game playing, but that game playing tended to monopolize the subjects´ behavior.

Table A-2 shows each subject´s expenditures on drinks for each session and visually examines the relationship between expenditure and game preference. Subjects spent all ten tokens in each session. Tokens not spent on drinks were, therefore, spent on games. The game subjects chose to play in the fourth session of the Pilot Study was assumed to be their preferred game. Visual inspection of Table A-2 reveals no consistent change in expenditures when subjects were confined to playing the non-preferred game.

Conclusions

Outside of minor adjustments made in the angle of the rater´s views of subjects, no procedural difficulties were encountered. Inter-rater reliability was judged to be of sufficient quality to make no further changes in the methods of observational data collection. The video games clearly engaged the subjects´ behavior for major portions of each session. Subjects' behavior between sessions was stable enough to suggest that stable responding could be achieved in each phase of the main experiment. Game preference did not appear to have an effect on choices between game playing and drinking. Whether the preferred game was available or not produced no consistent or significant changes in the patterns of token expenditure for any subject. This suggested that permitting subjects to choose between the two games and to change games at any time would not produce confounding effects in the main experiment. In general, the results of the Pilot Study suggested that the data were of sufficient quality to begin the main experiment.

APPENDIX B

INFORMED CONSENT FORM, DRINKING QUESTIONNAIRES, VIDEO GAME PLAYING QUESTIONNAIRE, POSTER ADVERTISEMENTS, NEWSPAPER ADVERTISEMENTS

INFORMED CONSENT TO PARTICIPATE IN RESEARCH

J. HILLIS MILLER HEALTH CENTER
UNIVERSITY OF FLORIDA
GAINESVILLE, FLORIDA 32610

You are being asked to volunteer as a participant in a research study. This form is designed to provide you with information about this study and to answer any of your questions.

1. TITLE OF RESEARCH STUDY

DETERMINANTS OF CHOICE BEHAVIOR

2. PROJECT DIRECTOR

Name: Denise Landau, M.S.

Telephone Number: 376-3659

3. THE PURPOSE OF THE RESEARCH

The purpose of this research is to investigate some of the variables which may influence choice behavior, especially choices between consuming alcohol and playing video games.

4. PROCEDURES FOR THIS RESEARCH

If you choose to participate in this experiment, you will be asked to participate in two or three one-hour sessions per week for a period of time of up to eight months. These sessions will be scheduled at times that are convenient for you and for the research personnel. You will receive $3.00 per hour for your participation. Two activities will be available to you during each session--drinking an alcohol beverage (80 proof vodka and orange juice) and playing video games. You will be required to engage in a simple, button pressing task to receive tokens which are exchangeable for either the alcohol beverage or video game playing time. How much of the alcohol beverage you drink and how much you engage in game playing is entirely up to you. You will be given a breath test to estimate your blood alcohol level twice (before each session, and at the end of each session). Before you start the sessions, you will be asked to complete some questionnaires about your drinking habits.

If you choose to participate, you must agree not to drive a motor vehicle or operate other machinery for at least four hours after completion of each session of the experiment. You must agree to remain in the laboratory until your blood alcohol level is below .05%. You must also verify that you are at least 21 years of age.

If you agree to participate, you will be assigned a number. This number, instead of your name, will be used to identify your data. Thus, any information about you that we gather during this study will be confidential to the extent provided by law. Only the investigators listed above and their research assistants will have access to the data.

5. POTENTIAL RISKS OR DISCOMFORTS

If you wish to discuss these or any other discomforts you may experience, you may call the Project Director listed in #2 of this Form.

For some persons, there is a slight possibility that consumption of alcohol beverages will result in negative physical effects, such as headache, nausea, or vomiting. In addition, alcohol consumption has been normally associated with alterations in liver functioning, reductions in memory efficiency, and slowing of motor coordination.

Therefore, before you are allowed to participate, we must be assured that you have no history of alcoholism, diabetes, heart disease, epilepsy, liver disease, or any other physical or psychological condition that would preclude your consuming alcohol. You must not participate if you are presently taking any medication that might have adverse effects if it ere to be combined with alcohol (e.g., valium, librium, phenobarbital). Women are, without exception, excluded from participating in this study. If any of these restrictions apply to you, please inform the experimenter.

6. POTENTIAL BENEFITS TO YOU OR TO OTHERS

Benefits to be expected from this study are $3.00 per hour for your participation and whatever information or satisfaction you may gain from participating in an investigation of human choice behavior. This study will facilitate future research on environmental determinants of choice behavior.

7. ALTERNATIVE TREATMENT OR PROCEDURES, IF APPLICABLE

N/A

8. GENERAL CONDITIONS

I understand that I will X receive money for my participation in this study. If I am compensated, I will receive $3.00 per hour for my participation.

I understand that I will not X be charged additional expenses for my participation in this study. If I am charged additional expenses these will consist of N/A

I understand that I am free to withdraw my consent and discontinue participation in this research project at any time without this decision affecting my medical care. If you have any questions regarding your rights as a subject, you may phone 392-3063.

In the event of my sustaining a physical injury which is proximately caused by this experiment, no professional medical *care received at the J. Hillis Miller Health Center exclusive of hospital expenses will be provided me without charge. This exclusion of hospital expenses does not apply to patients at the Veterans Administration Medical Center (VAMC) who sustain physical injury during participation in VAMC-approved studies. It is understood that no form of compensation exists other than those described above.

I also understand that the University of Florida and the Veterans Administration Medical Center will protect the confidentiality of my records to the extent provided by Law. The Study Sponsor, Food and Drug Administration or either Institutional Review Board may ask to review my records, however, the records will remain confidential as only a number and initial will be used.

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9. SIGNATURES

I have fully explained to ______________________________ the nature and purpose of the above-described procedure and the benefits and risks that are involved in its performance. I have answered and will answer all questions to the best of my ability. I may be contacted at telephone number 376-3659 or 392-4071.

Signature of Principal of Co-Principal Investigator Obtaining Consent	Date

I have been fully informed of the above-described procedure with its possible benefits and risks and I have received a copy of this description. I have given permission of my/my child´s participation in this study.

Signature of Patient or Subject or Relative or Parent or Guardian (specify)	Date
N/A	N/A
Signature of Child (7 to 17 yrs of age)	Date
Signature of Witness	Date

*See Section 8 of Instructions

Drinking Questionnaire

Age_____ Sex_____ Class in School (e.g., freshman)_____

The following questions relate to your alcohol consumption habits. Your honest answers would be greatly appreciated and will be held in strict confidence by the principal investigators of this study.

1. On the average, how often do you drink any kind of alcoholic beverage (beer, wine, or hard liquor) during a typical month? Check the one category which best describes your average frequency of drinking:

   ___I rarely drink
   ___about once a month
   ___2 to 3 times a month
   ___once or twice a week
   ___3 or 4 times a week
   ___nearly every day
   ___two times a day
   ___three or more times a day

2. When you drink any kind of alcoholic beverage, what is the average quantity you consume--that is, you consume this amount nearly every time or more than half the time you drink. Check one:

   ___I rarely drink
   ___1 to 2 4-oz. glasses of wine, 12-oz. cans of beer, or 1.5-oz. drinks
   ___3 to 4
   ___5 to 6
   ___7 to 8
   ___9 to 10
   ___more than 10

3. When you drink any kind of alcoholic beverage, how often do you have:

   5 to 6 drinks:
   ---Nearly every time
   ___more than 1/2 the time
   ___less than 1/2 the time
   ___once in a while
   ___never

3 or 4 drinks:

---Nearly every time
___more than 1/2 the time
___less than 1/2 the time
___once in a while
___never

1 or 2 drinks:

---Nearly every time
___more than 1/2 the time
___less than 1/2 the time
___once in a while
___never

PLEASE ANSWER YES OR NO TO THE FOLLOWING QUESTIONS:

1. Do you feel you are a normal or light drinker?

___Yes
___No

2. Do friends or relatives think you are a normal or light drinker?

___Yes
___No

3. Have you ever attended a meeting of Alcoholics Anonymous (A.A.)?

___Yes
___No

4, Have you ever lost friends or girlfriends/boyfriends because of drinking?

___Yes
___No

5. Have you ever gotten into trouble at work because of drinking?

___Yes
___No

6. Have you ever neglected your obligations, your family, or your work for two or more days in a row because you were drinking?

___Yes
___No

7. Have you ever had delerium tremens (DTs), severe shaking, heard voices, or seen things that weren´t there after heavy drinking?

___Yes
___No

8. Have you ever gone to anyone for help about your drinking?

___Yes
___No

9. Have you ever been in a hospital because of drinking?

___Yes
___No

10. Have you ever been arrested for drunk driving or driving after drinking?

___Yes
___No

THE FOLLOWING QUESTIONS ASK ABOUT YOUR HABITUAL USE OF VARIOUS TYPES OF ALCOHOLIC BEVERAGES. PLEASE CONSIDER YOUR DRINKING FOR THE LAST 6 MONTHS IN ANSWERING THE QUESTIONS AND TAKE ENOUGH TIME TO GIVE AN ACCURATE ANSWER TO EACH QUESTION.

If you never drink, check here:___

1. How many days a week do you drink some wine--at least one small, 4-oz. glass?
___days

2. On those days you do drink wine, about how many 4-oz. glasses of wine do you typically have?
___4-oz. glasses

3. How many 4-oz. glasses of wine do you have in a week, in total?
___glasses total

4. How many days a week do you drink some beer--at least one 12-oz. bottle or can?
___days

5. On the days you do drink beer, about how many 12-oz. bottles or cans do you typically have?
___12-oz. bottles or cans

6. How many 12-oz. beets do you have in a week, in total?
___beers total

7. How many days a week do you drink some liquor (e.g., whiskey, scotch, brandy, vodka, bourbon, gin, rum, etc.--but not including beer and wine)?
___days

8. On the days you do drink some liquor, about how many drinks do you typically have (a drink being 1 1/2 oz. of liquor--that is, a shotglass--alone or mixed)?
___drinks with 1 1/2 oz. of liquor

9. How many drinks of liquor do you have in a week, in total?
___drinks, total

10. When you do drink, how fast do you drink? (Here, a drink is a glass of wine, a 12-oz. beer, or one drink of liquor--straight or mixed.)
CIRCLE ONE: 7 or more drinks per hour
6 drinks per hour
5 drinks per hour
3 drinks per hour
2 drinks per hour
1 drink per hour
1 drink in two hours
1 drink in three or more hours

11. How many times have you gotten drunk in the last 6 months? By drunk, we mean loss of coordination, nausea, and/or inability to speak clearly?
___times drunk

12. What percentage of times that you do drink any alcohol do you get drunk?
___%

VIDEO GAME PLAYING QUESTIONNAIRE

Name________________________________ Subject Number____________

Age____________

Date____________

For each question, please circle the number which best describes your video game playing habits.

1. How often, on the average, do you play video games?

1	2	3	4	5
never	a few times a year	1-3 times a month	1-4 times a week	usually at least once a day

2. When you go to a video game arcade, how long a period of time do you usually spend there?

1	2	3	4	5
I never visit arcades	no longer than 10 minutes	between 10 and 20 minutes	40 minutes or longer	

3. On the average, how much money do you spend on video games?

1	2	3	4	5
none	1-10 dollars a year	10-40 dollars a year	40-80 dollars a year	80 dollars a year or more

4. If you had $10.00 in cash, and your favorite video game(s) was available, how much money would you probably spend playing?

1	2	3	4	5
none	under $2.00	between $2.00 and $4.00	between $4.00 and $8.00	over

5. If you were to go into a bar wherein your favorite video game(s) was available, how likely would you be to play?

1	2	3	4	5
most likely would not play	might play a game	most likely would play a game or two	most likely would play several games	probably play most of the time I was there

6. If you were to go into a convenience store wherein your favorite video game(s) was available, how likely would you be to play?

1	2	3	4	5
most likely would not play	might play a game	most likely would play a game or two	most likely would play several games	probably would stay and play 10 games or more

7. If you were to go into a shopping mall wherein your favorite video game(s) was available, how likely would you be to play?

1	2	3	4	5
most likely would not play	might play a game	most likely would play a game or two	most likely would play several games	probably would stay and play 10 games or more

8. How would you rate your expertise on the game you play the most?

1	2	3	4	5
novice	fair	average	pretty good	expert

9. Do you:
   - a) prefer to play shooting games?
   - b) prefer to play non-shooting games?
   - c) enjoy playing either shooting or non-shooting games?
   - c) not really have a preference?

(Please circle one of the above)

POSTER ADVERTISEMENT

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You will be paid $3.00 per hour for your participation.

1 1/2 hour sessions will be scheduled two or three times a week at times convenient for you and the research personnel for up to eight months.

For more information call: Laura Hobbs 378-9042
Please leave a message.
Your call will be returned
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APPENDIX C

INSTRUCTION BOOKLET FOR SLAY THE NEREIS (STN)
INSTRUCTION BOOKLET FOR DOWNLAND (DNL)

SLAY THE NEREIS

Introduction

You are the commander in charge of three mini-subs. During your mission, you soon discover that the area you were sent to scout is a dangerous one, teeming with several innocent-looking creatures--schools of fish, manta rays, starfish, jellyfish, and an occasional "Nereis," a marine creature which excretes a paralyzing poison. In addition to these native aquatic creatures, there is an enemy navy destroyer which fires depth charges with your submarine as its target.

It is difficult to maneuver in these murky waters filled with gaseous bubbles. You and your crew must use all your skills to navigate the mini-subs around these bubbles and learn how to effectively fire the missiles. The one and only fact you must never forget is to destroy or be destroyed.

Skill Level (0-15)

Level 0 is the easiest while Level 15 is the hardest. At Level 0, the pace of the game is the slowest, and it is much easier to hit the fish, manta rays, and other targets. You may want to start at Level 0 and gradually work up to Level 15 after you have become experienced with the joystick.

Maneuvering the Mini-Subs and Firing Missiles

After you enter the skill level, you are taken to your mini-sub which is underwater and near the bottom of the ocean floor. In the upper left corner, you see two reserve mini-subs above the surface of the water. These reserve subs are called into action one at a time when the submarine you are currently commanding is destroyed. (The game is over when all submarines have been destroyed.)

The ocean is full of bubbles. Although these bubbles are harmless, you must maneuver the sub around them by using the joystick. Hold the joystick with the red fire button farthest away from you. Then, move the joystick in the direction you want to go--up, down, left, or right.

To shoot an object, use the joystick to move the sub under the object and then press the red fire button to discharge a missile. The fire button makes a shooting noise when pressed. (Any object except a bubble can destroy a sub if you do not hit it first or stay out of its way.) If you destroy a bubble, you receive one point. It takes between two and four shorts depending on the location of the bubble. There are some hidden plants on the ocean floor that release new bubbles from time to time.

The Creatures of the Sea

A school of fish swims through the water back and forth across the screen and from the surface to the bottom. When a fish strikes a bubble, it reverses direction and once a fish reaches the ocean floor, it works its way partially up the screen.

When you hit a school of fish, it breaks up into two or more groups. You receive 10 points the first time you hit a fish and then the fish surfaces to the top of the ocean. The second time you hit a fish you receive 50 points and the fish is destroyed. If you shoot all the fish on the screen, a new school of fish appears at the top of the screen.

Occasionally, a depth charge sinks straight from the top of the screen to the bottom and leaves a trail of new bubbles in its wake. Remember--a depth charge can explode your sub, so either destroy it first or stay out of its way. You receive 100 points for destroying a depth charge.

Starfish, manta rays, and jellyfish bounce on the ocean floor moving across the screen. (When one of these creatures reaches a side of the screen, it disappears temporarily but then reappears at a different place in a few seconds.) Since bubbles do not block a starfish, manta ray, or jellyfish, you can´t hide behind a bubble to avoid them. If you kill one of these ocean-floor creatures, you receive 100-800 points. The closer the creature is when you kill it, the more points you receive.

The last mysterious sea creature which you may see is the dreaded Nereis. It is readily distinguished from the other creatures not only by its appearance but also by the unique sound it makes. Be on the lookout for the crafty Nereis for it may appear and disappear at any moment. You receive 500 points for each Nereis you kill.

If poison from the Nereis pollutes a bubble, any fish (or school of fish) coming in contact with the toxic bubble is immediately paralyzed and plunges to the ocean floor. Once a paralyzed fish (or school of fish) reaches the bottom, it is revived and can once again destroy your sub.

Scoring

Your total score is displayed above the water in the upper right corner of the ocean. The cumulated score for all depth charges, manta rays, starfish, jellyfish, and Nereises (hit by a single sub) is displayed in the middle of the screen above the water. When a sub is destroyed, you can hear the explosion, and a reserve sub is soon launched and appears near the bottom of the screen. The bubbles float up one line toward the top of the screen and you´re ready for action again.

You receive an additional sub for each 10,000 points you score. You may have up to four submarines at any one time.

End of a Game

When every submarine has been destroyed, all action stops and the screen clears in a few seconds to display the scoreboard.

The scoreboard can display up to nine games. for each game listed, the player´s name, score, and skill level is shown. (If more than nine games are played, only the top nine scores are displayed.) The scores are shown in descending order.

At the bottom of the screen, the computer asks you:

NEW GAME (Y OR N)?

To play a new game at the same level, press the fire button. The screen changes to the ocean scene and you have three new submarines with which to start over.

Note: If you do not press a key to indicate whether you want to play a new game within a few minutes, the screen clears and then the computer takes over and plays for you. You can just sit back, relax, and watch the computer in action. Since there is an unlimited supply of submarines for the computer, the game does not end until you press the reset button or turn the computer off. If you press the reset button, the title screen reappears.

Scoring Table

Object	Points
Bubble	1
Fish (hit the first time)	10
Fish (destroyed the second time)	50
Depth Charge	100
Starfish, Manta Ray, Jellyfish	100-800 (the closer the creature, the higher the points)
Nereis	500

DOWNLAND

Introduction

You found an opening into what looks like an underground cavern! You enter the cave, and suddenly a rock slide cuts off your exit. There´s no turning back. You have no choice but to continue through the cavern, looking for another exit.

As you explore the cave, you realize that others have been here before. Ropes are hanging from ledges throughout the cave, and treasures, such as diamonds and bags of gold, are scattered everywhere. Suddenly you come upon a key. The key must be magical for when you pick it up, a door appears. You must get to that door! Surely, it will lead you to safety.

Collect the treasures and keys, and make your way to the door by climbing the ropes and jumping onto the ledges. But be careful! It will take all your skill to keep from falling or being hit by acid drops or boulders. Also, beware of the poisonous bat that is waiting to destroy you?

Before the Game Begins

When you turn on your Color Computer, the screen displays the name of the game and the copyright information. To indicate that you want to play a one player game, push the joystick to the left. For a two player game, push the joystick to the right.

To start the game, press the fire button on your joystick.

Playing the Game

You control the man in the cave by moving the joystick in the following directions:

```
                    climb up rope

     move left            *            move right

                   climb down rope
```

To make your man jump, press the button on the joystick.

There are a series of 10 different chambers (0-9), in this cavern. Within each chamber, you see bags of gold, diamonds, and keys. These items appear in different spots depending how far you are in the game. As you travel through the cavern, pick up as many of these treasures as possible. Accumulating these items increases your score. To pick up these treasures, touch them by jumping or swinging one arm off a rope.

The keys are very important. When you pick up a key, a door in the cavern opens. (You may or may not see the door at this time.) These doors let you move from chamber to chamber. Not all the keys are accessible from your position. For example, in the second chamber, there is usually a key in an upper section of the chamber that you cannot reach. Eventually, as you travel through the next two chambers, you will exit a door that lets you backtrack through the chambers to collect the remaining key. Without it, a future door will not open.

You are given four men with which to maneuver the cavern. They can be killed by the boulders, the acid drops, the bat, or by falling. When you enter each chamber, a counter in the lower right corner starts. When it reaches 0, the deadly bat appears, and it destroys you if you cannot get out of the chamber. Your remaining men are shown on the upper left of the screen.

After losing all four men, the game is over. The copyright screen reappears, and you can restart the game by pressing the button on the joystick.

Scoring

You accumulate points by collecting keys, bags of gold, and diamonds. The points for each item vary randomly. Your score for the current game appears on the lower left side of the screen. The copyright screen shows the highest score made during the current playing session and the score for the preceding game for players one and two.

Strategy

Downland is an exciting game of skill, but it will take time to master. Below are a few hints that may help:

- When jumping onto a rope, maintain your forward motion as you make the jump. Once on the rope, stop the forward motion. Your man will not grab hold of the rope while standing still.

- When jumping onto a rope, start the jump a short distance from it. If you wait until you are too close, you will overshoot the rope.
- When jumping to a ledge from a rope, make sure you are almost even with the top of the ledge. If you are too far above, the jump will count as a fall.
- When jumping to a ledge from a rope, you do not have to maintain a forward motion.
- When moving around the falling boulders, watch them carefully and time your movements between them.
- When you move into the higher level chambers, the acid drops fall closer to the rope. It may be necessary for you to swing to one side of the rope to avoid the drops.
- When you move into the higher level chambers, watch for the horizontal ropes. After jumping onto the rope, maintain your forward motion, and you will climb hand-over-hand across these ropes.

To Get You Started

To give you an example of the types of challenges you will encounter playing Downland, the following description steps you through the first three chambers.

Chamber 0

The game begins with you located in the lower right corner of the chamber. Acid drops are falling and boulders come rolling down at regular intervals. Start running along the bottom of the chamber. Be sure to watch the falling drops. Two treasure items are located along this bottom level. Jump up as you run beneath them to pick them up. If a boulder is closing in on you, jump onto one of the three small ropes hanging from the ledges above.

When you get to the long rope on the left side of the chamber, jump onto it. Start climbing the rope, and when you are level with the top of the small ledge on the right and no acid drops are falling, jump onto the ledge. Jump up and capture the treasure above this ledge.

Now jump from this ledge onto the next rope. If no drops are falling you can continue onto the next rope. When you get to this rope, wait. The best way to get to the rope leading to the next level of the chamber is to wait on the third rope until a boulder has gone by and then without stopping, jump onto the ledge and run and jump onto the fourth rope.

Maneuvering the rest of this chamber is easy, but WATCH THOSE ACID DROPS!

Chamber 1

When you get into the second chamber, you must immediately jump onto a rope. Near the top of the rope, jump onto a small ledge to the right. When no drops are falling, jump onto the second rope and climb to the bottom of the chamber. Run across the bottom of the chamber and jump onto the next rope. From there you must jump onto the bottom ledge on the left.

To move up these three ledges, move your man to the outside and position his feet so they overhand the ledge slightly.

Simultaneously, run and jump onto the next ledge. Maneuver each one of these ledges the same way.

Once you get to the top ledge, jump to the rope, and then jump to the ledge on the right. An open door leads you into the next chamber.

Notice that one key remains in this second chamber. You will have the opportunity to return later to collect it.

Chamber 2

In this third chamber, you are immediately greeted by rolling boulders. You must jump over them to get to the first rope. From this rope, you will have to either jump to the ledge on the left or swing to the right from the rope to collect the key.

Climb back down the rope and prepare to jump onto the slightly elevated ledge on the right. Again, you have a series of three ledges to climb. Watch the boulders carefully. Notice that they land in alternating spots on the bottom ledge each time (outside and middle). After a boulder lands in the middle of the ledge, make your jump and run to the inside. Wait for the next boulder and then back up, run, and jump onto the next ledge. Wait again and then make one more jump. You are now at the door leading to the fourth chamber.

Now, you´re on your own. What awaits you is still a mystery. Sharpen your skills and prepare to face many fascinating challenges as you maneuver the various chambers in Downland.

GOOD LUCK!

APPENDIX D

FIRST SESSION TRANSCRIPTS OF INSTRUCTIONS FOR ALL SUBJECTS, PILOT AND PHASE 1; TRANSCRIPT OF INSTRUCTIONS, PILOT, SESSIONS TWO THROUGH FOUR; TRANSCRIPT OF INSTRUCTIONS FOR ALL SESSIONS AFTER THE FIRST, PHASES 2-4, FREE RESPONDING, AND FREE WORK

FIRST SESSION TRANSCRIPTS FOR ALL SUBJECTS

Please read the Informed Consent Form. Let me know if you have any questions or concerns before you agree to participate. . . . Now please answer all the questions on these questions. If you are unsure about the meaning of a question, please ask me. Notice that there are four sets of directions, here, here, here, and here. Read and follow these directions carefully, as they are different. . . Here are the instruction booklets for the video games available. Please read them over. Let me know when you are finished or if you have any questions. You can not take the booklets into the session with you. Disregard any reference to using the computer in the booklets. You see, we will have control of the computer. If you wish to change games or levels all you have to do is let us know. . . . Okay. Come on in here. Please sit here. Now when I speak to you through this hole in the wall and tell you to begin, you are to push this button like this. After you push for a while, you will see the number change here from zero to one. When you reach ten, I will come back in and I will give you ten tokens and more instructions. . . . Okay you can begin. . . . Okay, here are your ten tokens, one for each number on the counter. One token will buy one drink. When you want a drink, put one token in this canister. You may only buy one drink at a time. The drinks, screwdrivers--vodka and orange juice-- will appear here in this hole after you have paid a token. When you drink please be sure to sit in this chair. Do not take the drink with you over here or over there. One token will also buy six minutes of game playing time. When you want to play, pout one token in this canister. You may only buy one six minutes worth at a time. After you pay, we will release the game so that you can play. When your six minutes is up, the game will be put on hold until you pay another token. Please sit here when you are playing the game. You can not take your drink over here with you, but, you can change areas at any time so you can play a while and drink a while and then play a while, you see? We will accurately reserve your time for you that you bought with the token so that you will get your whole six minutes. We will also put the game on hold when you leave the chair so you can start again where you left off. If you don´t spend all of your tokens, you can not keep them for the next session. Tokens can only be spent in the session they are earned. If you do spend all of your tokens, you still have to stay here until the hour is up, whether or not you have any tokens, understand? See this clock? It is always set for twelve. When it says one o´clock, your hour session is up. Okay. Which game would you like to play? If STN, then, What level would you like it set for? There are zero through fifteen levels . . . for both games, then You can change games or levels at any time, by letting us know. We will see you telling us. . . . Okay. You can start now.

TRANSCRIPT OF INSTRUCTIONS, PILOT, SESSIONS TWO THROUGH FOUR

"Do you remember the rules from last time? Once again you need to push the button until the counter displays ten. . . . Okay. Go ahead. . . . This time the rules are just as they were last time. One token buys one drink or six minutes of game playing time. However, today,

a) if session two then, "only one game will be available, Slay the Nereis. For which level would you like the game set? There are levels zero through fifteen. You can change levels at any time by letting us know,"

b) if session three, then, "only one game will be available, Downland."

c) if session four, then, "both games will be available. Which game would you like to play?" If Slay the Nereis, then, "Which level would you like? Zero through fifteen levels are available," for both games then, "You can change games or levels at any time by letting us know."

For all sessions then, "Okay. You can begin now. Remember, you must stay until the clock is at one o´clock whether or not you have any tokens left. If you do have tokens left over, you can not use them in another session."

TRANSCRIPT OF INSTRUCTIONS FOR ALL SESSIONS AFTER THE FIRST, PHASES 2-4, FREE RESPONDING, AND FREE WORK

Phases 2-4, "Do you remember the rules from last time? Once again you need to push the button until the counter displays ten. . . . Okay. Go ahead."

Free Responding, "here. This time you don´t have to work for them. There are more here than you could possibly spend."

Free Work, "This time you can earn tokens whenever you like during the session. You can earn as many or as few as you like. it´s up to you. When you are button pressing, we will stop the clock so it won´t be included in your one hour session time. We will turn the clock back on when you stop button pressing and get out of this chair. When you are button pressing, each time the counter changes over to a new number, we will place the token you have earned here in the hole in the wall. Understand?"

All Phases, "This time the rules are pretty much as they were last time. One token will still buy one drink. ___(appropriate number) tokens will buy six minutes of game playing time today. Remember, six minutes of game playing now costs ___ tokens. Both games are available. Which game would you like to play?" If Slay the Nereis, then, "Which level would you like? Zero through fifteen?" for both games then, "You can change games or levels at any time by letting us know. . . . Okay. You can begin now. Remember, you must stay until the clock is at one o'clock whether or not you have any tokens left. If you do have tokens left over, you can not use them in another session."

APPENDIX E

WORK AREA DURATION PER SESSION PER SUBJECT; NUMBER OF GAMES PLAYED PER SESSION, PER SUBJECT; BLOOD ALCOHOL LEVEL PER SESSION, PER SUBJECT

Figures E-1 through E-18 summarize the results obtained in the experiment for work area duration, number of games played, and blood alcohol level. These results yielded very little interpretable information, and so were not presented in the Results section (Chapter III).

Work Area Duration

Figures E-1 through E-6 show the durations subjects spent in the work area per session. Subjects button pressed very rapidly and, overall, earned tokens at a fairly constant rate throughout the experiment. "Peaks" in responding for Subject 11 on sessions 6 and 36 were due to such rapid presses that the recording apparatus could not register all of them. Consequently, not all button presses incremented the fixed ratio 100, (FR 100), and he had to spend more time in the work area.

Number of Games Played

Figures E-7 through E-12 illustrate the number of games that subjects played per session. All subjects began within the first three sessions to end games prematurely that they had begun with poor performance by "killing off their man" or "blowing up their submarine."

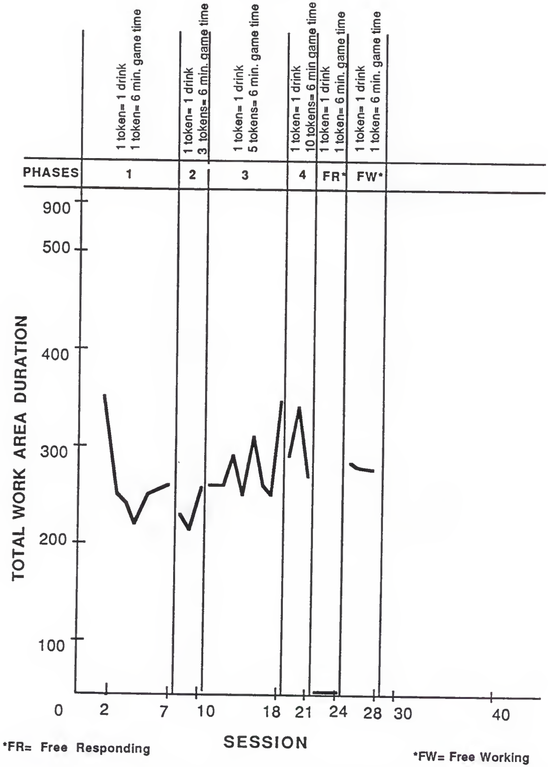


Figure E-1. Subject 6--Work Area Duration per Session in Seconds.

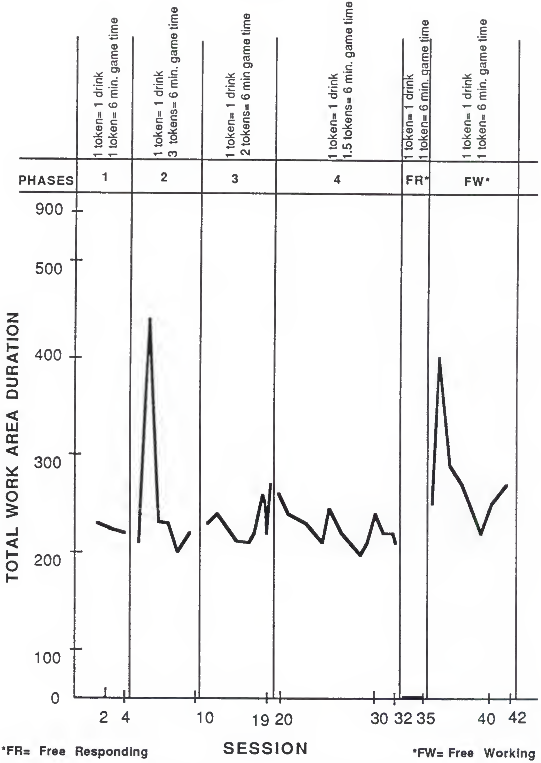
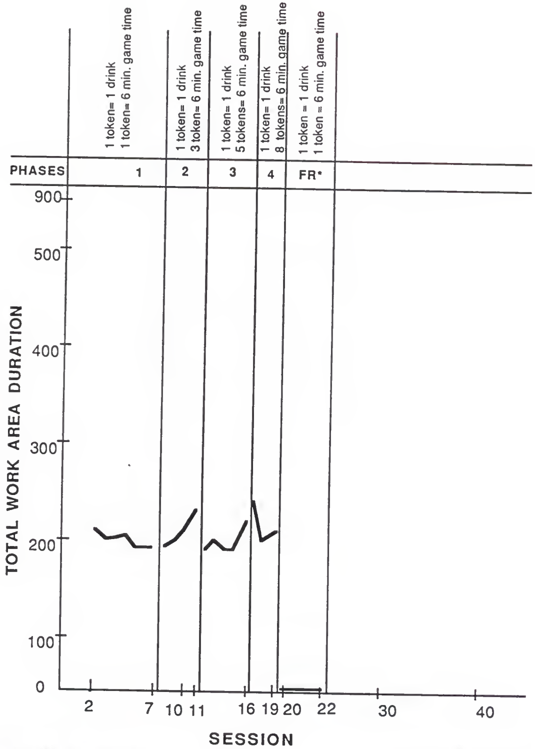


Figure E-2. Subject 11--Work Area Duration per Session in Seconds.



*FR= Free Responding

*FW= Free Working

Figure E-3. Subject 14--Work Area Duration per Session in Seconds.

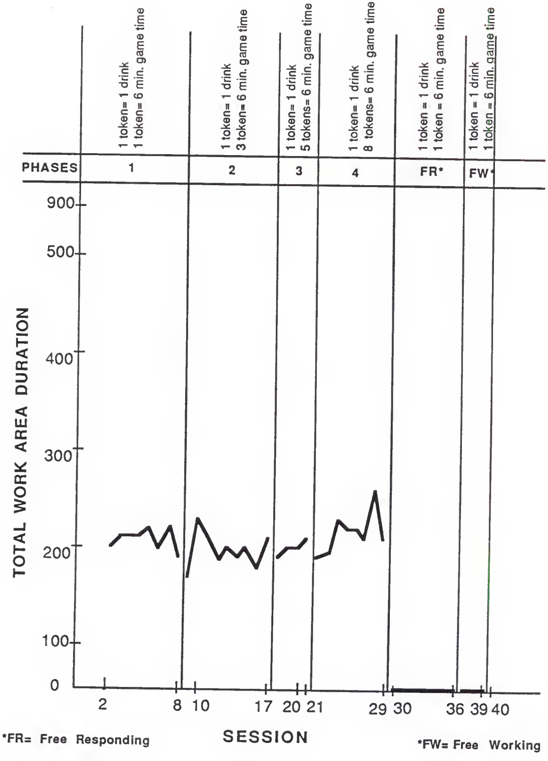


Figure E-4. Subject 16--Work Area Duration per Session in Seconds.

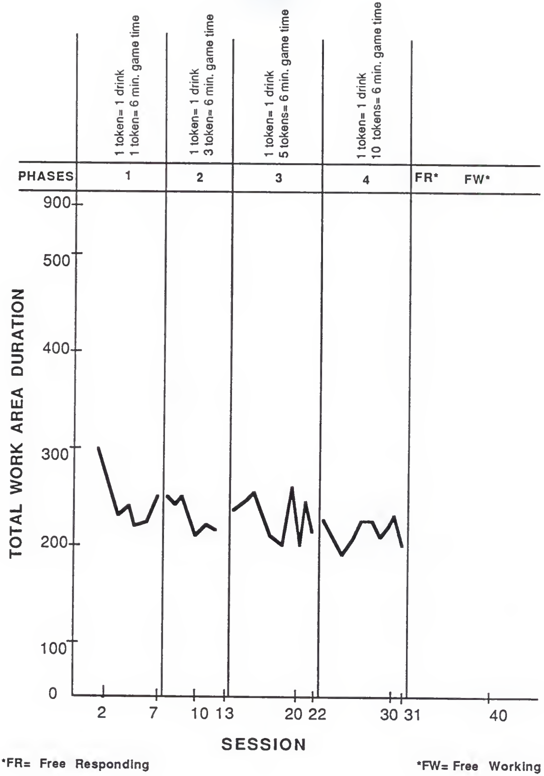


Figure E-5. Subject 18--Work Area Duration per Session in Seconds.

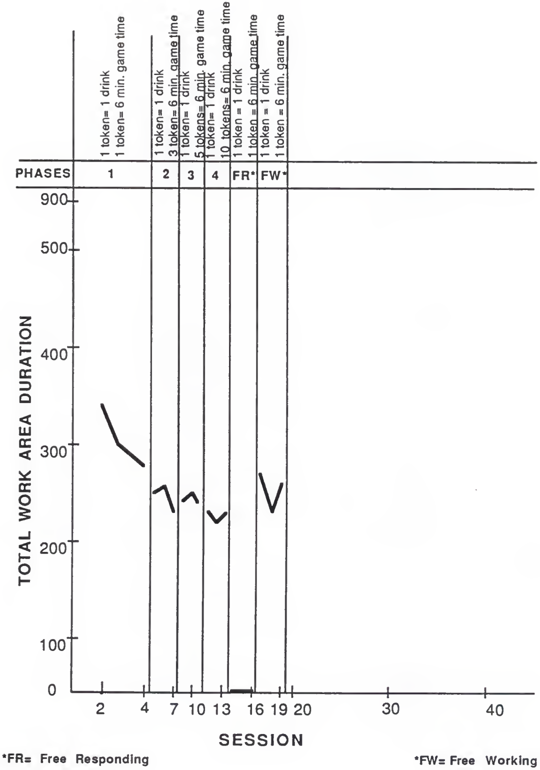


Figure E-6. Subject 19--Work Area Duration per Session in Seconds.

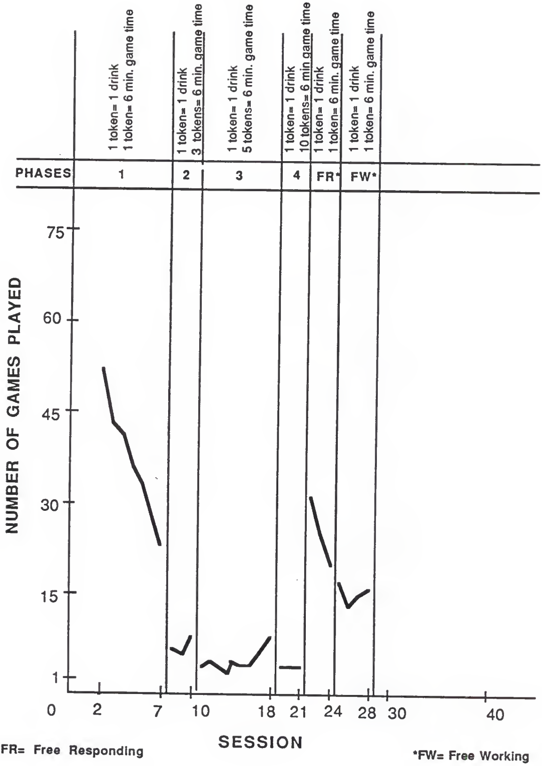


Figure E-7. Subject 6--Number of Games Played Per Session.

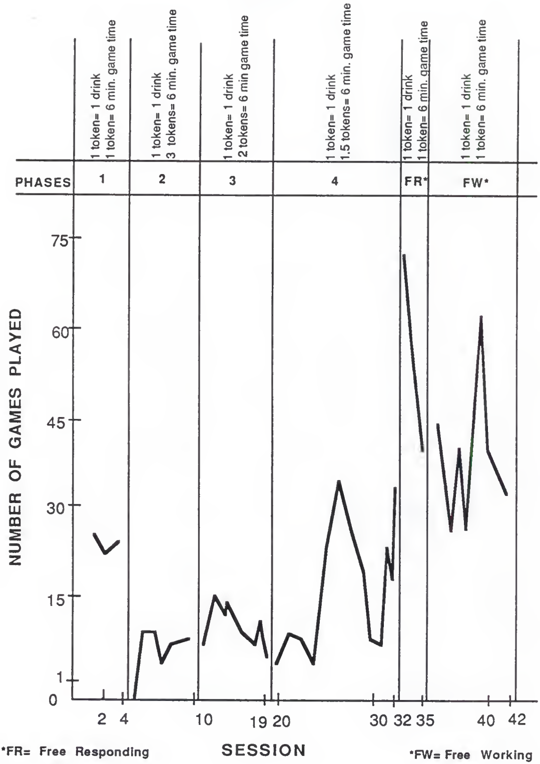


Figure E-8. Subject 11--Number of Games Played Per Session.

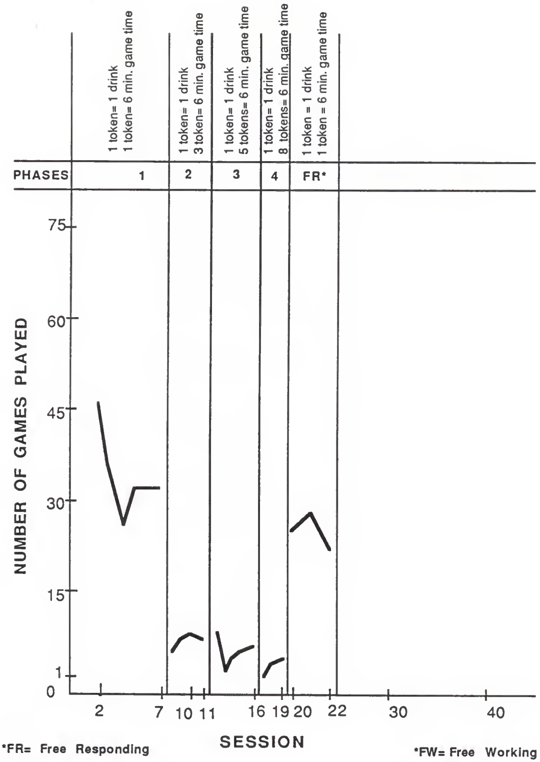


Figure E-9. Subject 14--Number of Games Played Per Session.

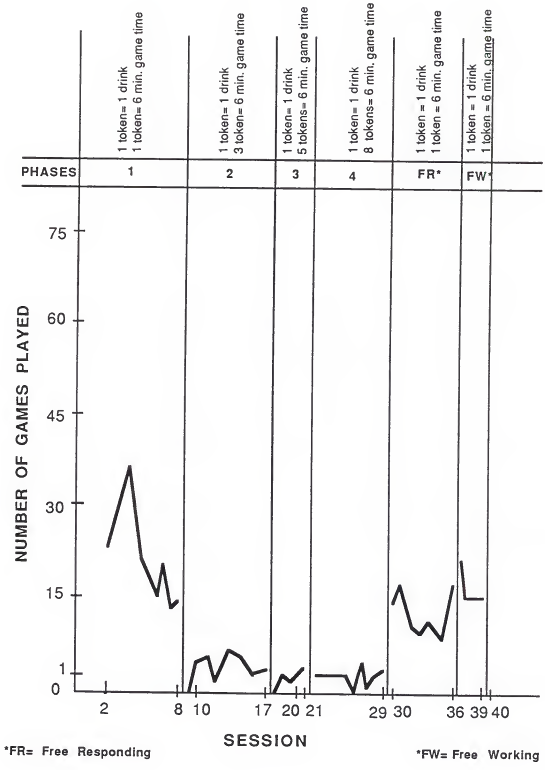


Figure E-10. Subject 16--Number of Games Played Per Session.

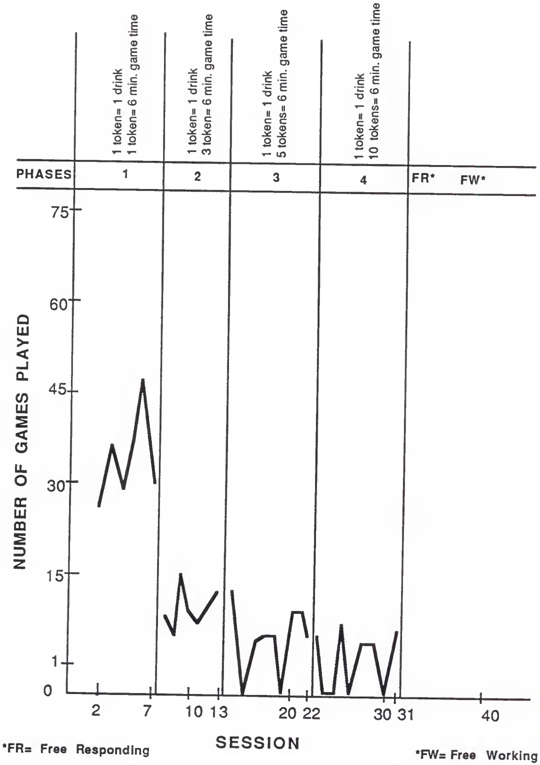


Figure E-11. Subject 18--Number of Games Played Per Session.

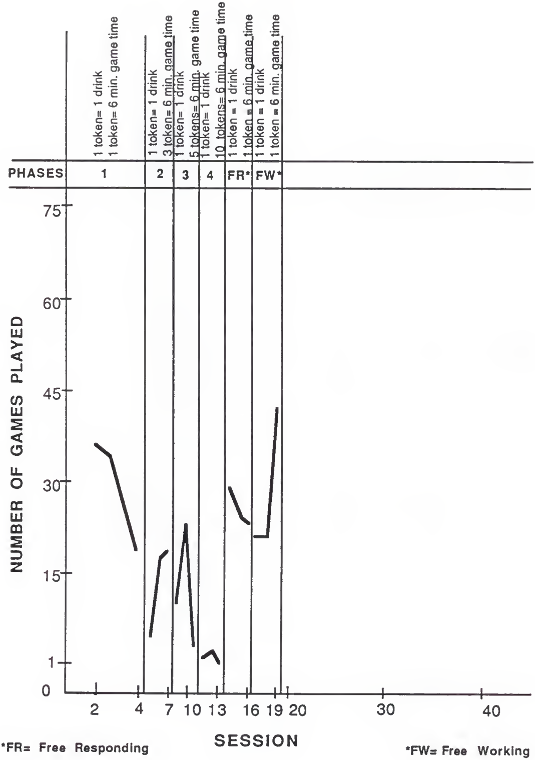


Figure E-12. Subject 19--Number of Games Played Per Session.

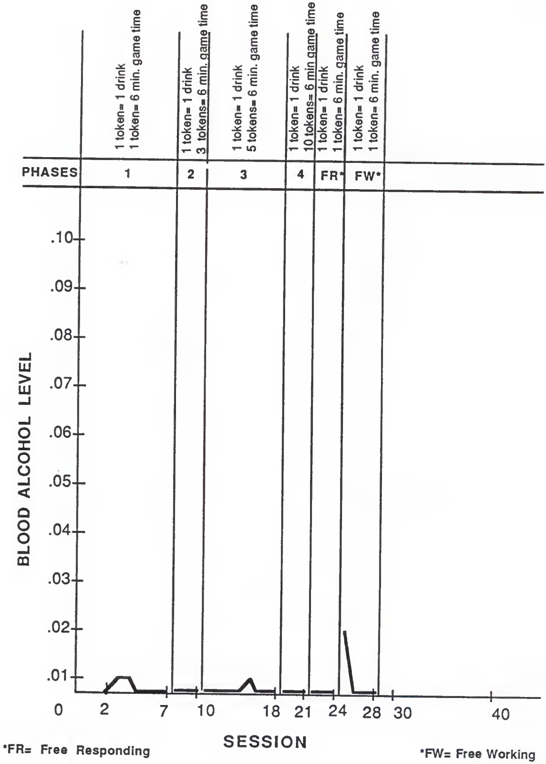


Figure E-13. Subject 6--Blood Alcohol Level per Session.

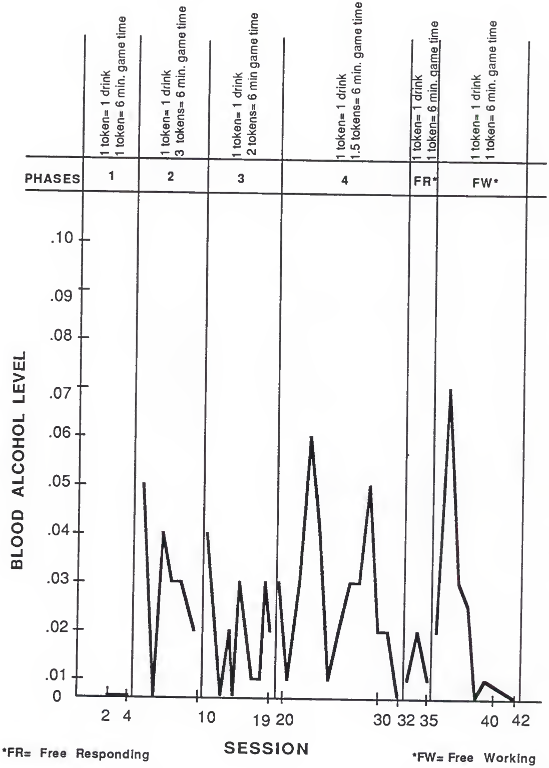


Figure E-14. Subject 11--Blood Alcohol Level per Session.

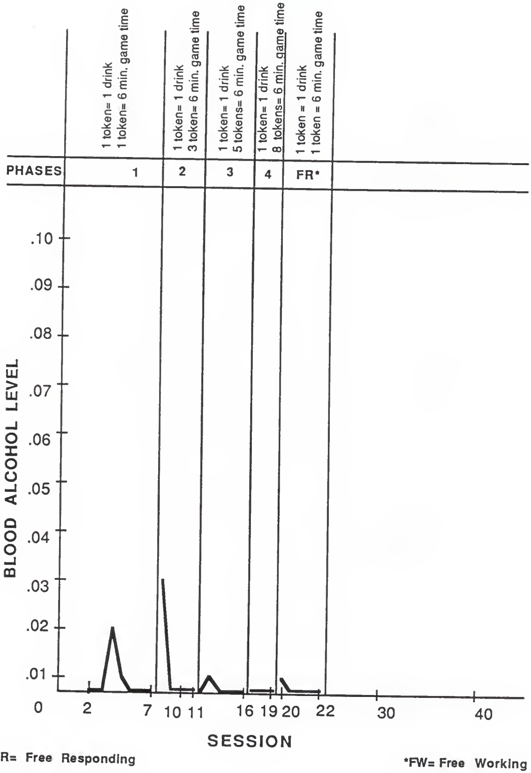


Figure E-15. Subject 14--Blood Alcohol Level per Session.

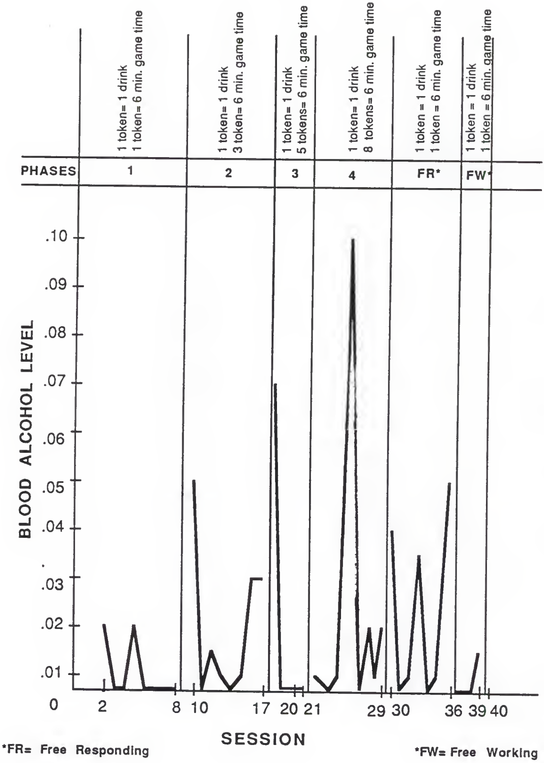


Figure E-16. Subject 16--Blood Alcohol Level per Session.

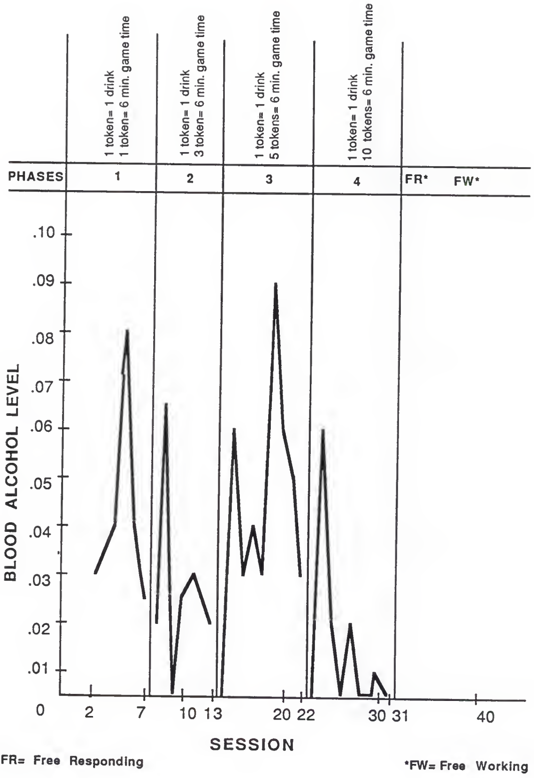


Figure E-17. Subject 18--Blood Alcohol Level per Session.

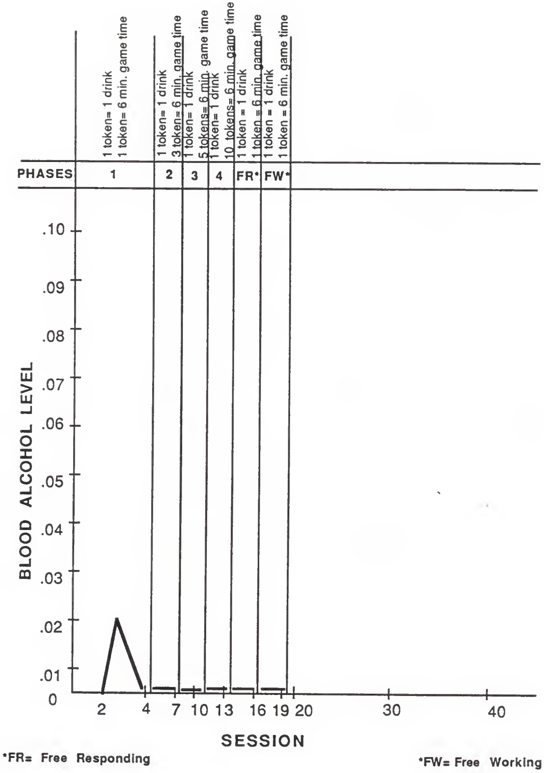


Figure E-18. Subject 19--Blood Alcohol Level per Session.

As a result, the number of games is spuriously high as a reflection of skill. It does, however, indicate opportunities for practice. Subject 18 appears to have had the least practice while Subject 16 had the most.

Blood Alcohol Level

Figures E-13 through E-18 depict each subject´s blood alcohol level immediately post-session for each session. Visual inspection reveals that blood alcohol levels correspond minimally with the number of drinks consumed (see Figures 3-13 through 3-18) both between and within subjects. The former is likely to be at least partly due to physiological differences. Diet possibly contributed to both. However, between and within subject differences were probably most influenced by the alcohol consumption patterns exhibited in the session. For example, subjects drinking at the beginning of the session are likely to have had markedly different blood alcohol levels post-session than when they drank at the end of the session.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Rudy E. Vuchinich

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